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ABSTRACT

This publication is the course book for a correspondence course in pest control with the Pennsylvania State University. It contains basic information for agricultural producers on pest management and the proper and safe use of pesticides. The course consists of eleven lessons which can be completed at one's leisure. The first nine lessons contain information applicable to all states while the tenth lesson reviews federal and state pesticide laws, particularly those of Pennsylvania. The glossary is the eleventh lesson. The first nine lessons cover such topics as management of common insects and mites, weed control and herbicides, plant disease control, pesticides formulation and toxicity, and pesticide safety. The course book format is a text lesson followed by a series of questions to be completed from the text. Correct answers to the questions are included. This publication may be adaptable to the secondary school science or environment class. (HM)

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Correspondence Courses
in Agriculture, Family Living and Community Development

The Pennsylvania State University
College of Agriculture
University Park, Pennsylvania

Pest Management and Environmental Quality

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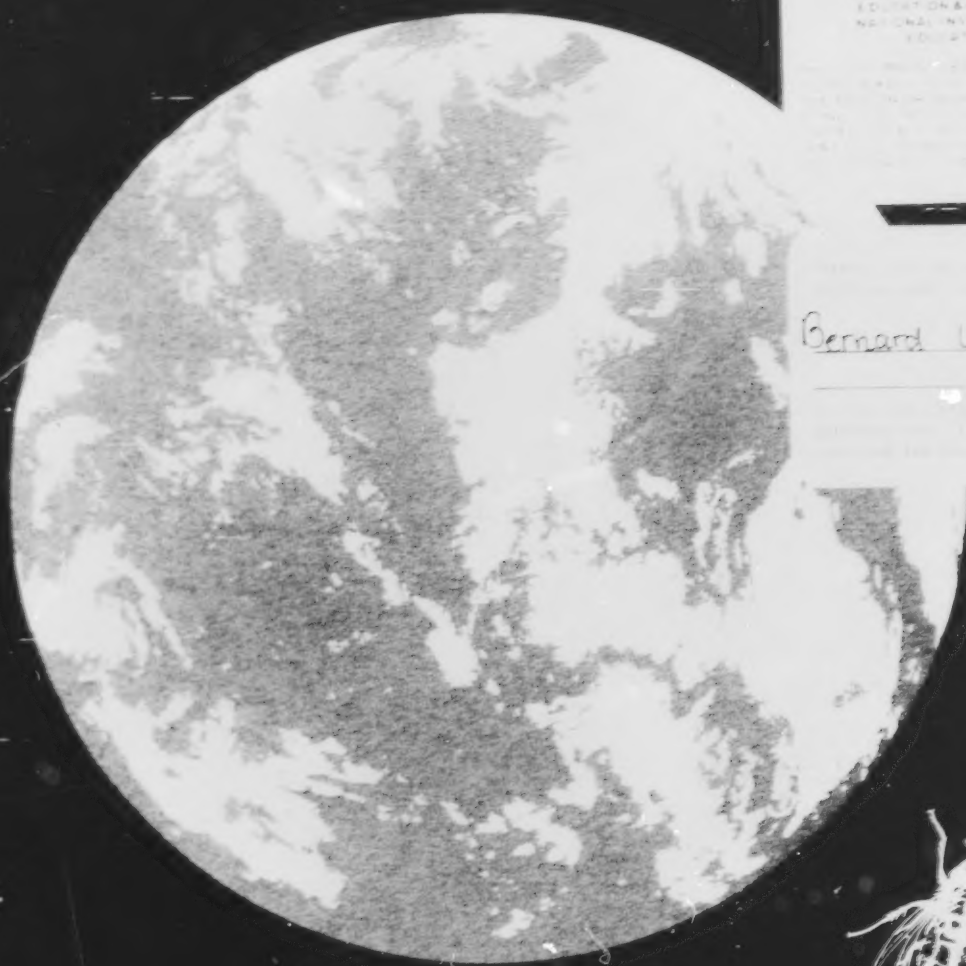
U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

Bernard Lukes



SE 023 122

COURSE 181

PEST MANAGEMENT AND ENVIRONMENTAL QUALITY

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First Edition

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To our students

Welcome to the Correspondence Course studies of the College of Agriculture. We hope that your correspondence education will be a rewarding and enriching experience.

Pest Management and Environmental Quality, Course No. 181, contains basic information for agricultural producers on pest management and the proper and safe use of pesticides. The course consists of eleven lessons. The first nine contain information applicable to all states. The tenth lesson reviews federal and state pesticide laws with particular emphasis on the Pennsylvania Pesticide Control Act of 1973. The eleventh lesson consists of a glossary.

Study suggestions

We suggest that you read, and answer if possible, the questions found at the end of each lesson prior to reading the lesson. After you have studied the lesson, go over the questions again. Then check your results by referring to the correct answers found on the bottom of the second page. Do not return the answer sheets. They have been provided as a study aid to assist you with the lessons.

A glossary of terms is included at the end of the manual. You might find it helpful to familiarize yourself with the terms used in the text even before studying the lessons. You can also refer to the glossary as needed as you read the lessons.

Study the lessons as time permits. There is no time limit on the completion of the course. Make personal assistance part of your correspondence education. Questions may arise that are not answered in the course. Feel free to ask questions. Please submit questions on separate paper rather than on the question sheets. Questions will be referred to faculty members for reply.

Good luck with your correspondence course.

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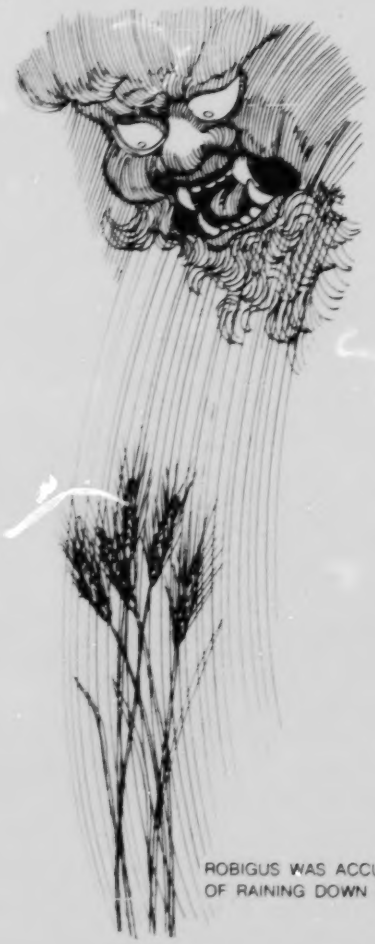
Lesson 1
INTRODUCTION TO PEST MANAGEMENT

MAN ORIGINATED AS A HUNTER



ROBIGUS WAS ACCUSED OF RAINING DOWN BLIGHT

Pests of various kinds have "pestered" man from the beginning of time. Pests — organisms that interfere with desired goals — include a long list of plant and animal disease-causing organisms, insects, weeds, rats, mice, some birds, and predatory mammals.

Man originated as a hunter of animals and fish and as a gatherer of berries and other foods. During this time, he worried little about pests except for the large predatory animals that might attack him.

As society evolved, families banded together to protect themselves from these wild animals. However, they continued to follow the herds of wild animals and to search for suitable food plants. Their goal — to obtain an adequate food supply in a comfortable climate — was reached when men learned they could tame some animals and grow and propagate some food plants; thus, a crude form of agriculture came into being.

Man could now grow some of his food instead of having to keep moving in search of food. But as more and more plants of the same kind were grown in a relatively small area, insect pests and plant diseases began to be recognized as destructive to the crops. He recognized these devastating organisms as "pests" because they interfered with his goals. Pests had become his competitor. Crops and domesticated animals were constantly troubled by insects and diseases; weeds invaded growing crops to choke off their vigor. Records from man's earliest history reveal how these crop plants were damaged by insects and diseases.

Pestilence and famine have always troubled man. Evil spirits were often blamed for these crop failures. Biblical writings say that angry gods were responsible for bringing hordes of locusts down upon the land.

The Roman and Greek god, Robigus, was accused of "raining down blight onto the fields" (the rust diseases of wheat). Diseases affecting rice caused widespread famine in China. An infamous famine that directly influenced the population of the United States was caused by late-blight destruction of the potato crop in Ireland in the middle of the 19th century. Over one million Irishmen starved as a result of this famine and thousands migrated to the United States to become a part of the growth of this country.

Society was in a dilemma — man liked the idea of living in a community and had become used to — and expected — food on his table that he grew in his fields. Even if he wanted to return to a hunting-and-gathering way of life, he couldn't; the population was now too large to support such primitive methods. So man, rather than changing his way of life, decided to fight the pests to save his crops, his stores of food, and his livestock.

It wasn't difficult for early agriculturists to understand how

INSECTS COULD BE SEEN

predatory animals, birds, and insects caused damage. Insects could be seen chewing on the leaves, fruits, and seeds of plants. Their bite and sting could be felt. The wolf and tiger were seen killing and carrying off young lambs. Weeds were also soon recognized as the good plants' competition.

Plant and animal diseases were difficult for early man to understand. In most cases, he couldn't see the organism that caused the damage. Only the symptoms were there. It was not until the invention of the microscope and the work of Louis Pasteur that the microorganisms' role in causing plant and animal diseases began to be understood. Until then, diseases were blamed on a variety of reasons, ranging from evil spirits to bad weather. For many plant diseases, bad weather was indeed partially to blame.

For many centuries, mystery surrounded the causes and occurrences of crop failures and pestilence, and the mystical beliefs prevented their cures. A tribe's medicine man was looked upon with awe because he was believed to possess supernatural powers for curing human ailments and animal and plant disorders. His healing concoctions included mud, manures, pulverized bones, organs of animals, minerals, and in later years chemical preparations became part of his wares. For some unknown reason, chemical preparations were believed to have magical properties. Many types of mixtures were used on plants, animals, and humans. Unfortunately, the cure was often worse than the ailment — the plants withered and the animals and people often died from the treatment. However, through accident and good luck, a few effective materials were found.

MECHANICAL CONTROL

Pest control measures

The first pest control measures were crude. Weeds were pulled by hand, rats and predators were clubbed to death, beetles and worms were picked off and mashed, but plant diseases were left to the medicine man's potions.

Early uses of pesticides were directed mainly against insects; however, "pest-averting" sulfur, introduced about 100 B.C., was used against both insects and plant diseases and is still used to control some mites, mildew, and few other plant fungi. Arsenicals were used as insecticides against chewing insects as early as 50 A.D. Several plant-derived insecticides, such as hellebore, were used for body-lice control; nicotine was used against aphids. About 1850, carbon disulfide was used as a soil fumigant to control grape phylloxera on the roots of grapevines in Europe. Chemical control of plant diseases got a big boost when Bordeaux mixture was developed in France during the 1880's. Before this, weed control chemicals were limited to salt and arsenicals that "burned" off the foliage. It was not until the 1940's with the advent of selective herbicides, such as 2,4-D, that widespread chemical control of weeds was possible.

POPULATION SOARED

As population soared, agriculture expanded. And as the agricultural produce increased, so did the pests. The slash-burn-plant-and-abandon system of agriculture used in the tropics provided a minimum of opportunity for insect and disease pests to develop. However, when crops were grown and livestock grazed on the same areas continuously for many years in favorable climates, pests had good opportunity to build up to harmful levels. Although the populations of pests may still be within bounds of profitable agricultural production, significant annual losses in livestock and crops occur.

The early crops and livestock, in general, were selected from the wild varieties and species in the regions where they were domesticated; however, as man pushed into new territory he took with him plants and animals that had never before been in these new environments. As might be expected, native insects and diseases of minor importance quickly adapted to the new introductions and soon became major pests. Man also carried with him numerous pests from the old homeland into his new frontier. Some developed into extremely destructive pests because the checks and balances provided by insect parasites and predators in the homeland to keep the pests in check were absent in the new environment and the pest population exploded in the new land. A few of these destructive pests brought by man into this country are gypsy moth, European corn borer, Japanese beetle, Dutch elm disease, and chestnut blight. In the case of chestnut blight, the American chestnut had no resistance to the blight fungus. The Asiatic chestnut had evolved in association with the fungus over thousands of years and much resistance was present in Asian chestnut trees.

Mechanized agriculture has compounded some pest problems. Vast acres of the same crop, and often the same variety, can be planted and harvested because of mechanization. The trend has been to either continuous cropping on the same land or to short rotations. With many acres of the same crop and variety, same age, same size, on the same land year after year, troubles are apt to appear. In this situation, if one crop plant is susceptible to a disease organism or an insect, millions of other plants may be equally susceptible.

Chemical pesticides became an important part of modern agriculture during the 1940's. Real concern did not focus on pesticides as pollutants until DDT was used on a world-wide basis after World War II. Some of the major factors that focused the world's attention on the hazards of pesticides to the environment were:

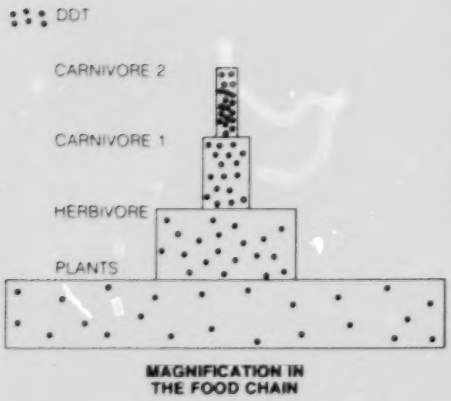
1) Other organisms besides the target species were affected. Other kinds of organisms, in addition to the one for which the pesticide was intended, were either killed or adversely affected. For example, when DDT was applied to a lake to kill mosquito larvae, in some instances fish, turtles, and beneficial aquatic life were also destroyed. The use of a poisoned bait, such as strych-

nine, to kill mice in an orchard, could also kill any beneficial animal that accidentally ate the bait.

2) Some pesticides are persistent and remain toxic for years. A number of pesticides degrade, or break down into nontoxic materials very slowly. Thus, they create a hazard to many types of organisms long after the initial application. Some of the long lasting pesticides include lead, the arsenicals, mercury, and strychnine. Other pesticides that degrade slowly include some in the organo-chlorine family, such as DDT, aldrin, dieldrin, and endrin.

3) Some pesticides can be stored in the body's fat and tissues for a long time. Small levels of pesticides are excreted with the milk of lactating animals. Low levels of persistent pesticides may also remain on plants and in animals that are eaten by humans and other animals.

4) In the biological concept known as the food chain, some persistent chemicals follow a magnification process in each step up the chain. If DDT were applied to the lake to control the mosquito larvae, the larvae would take up minute quantities of the pesticide; minnows eat the mosquito larvae and store higher levels of the chemical than were in the mosquitoes; small fish eat the minnows; large fish eat the small fish; and at each step up the food chain greater amounts of the pesticide are stored in the body.



MAGNIFICATION IN THE FOOD CHAIN

5) Living organisms can develop resistance or be tolerant to pesticides. In many instances, insects and disease organisms have developed resistance to pesticides which requires constant shifting to other pesticides to obtain effective control. Weed control chemicals (herbicides) are sometimes so effective in eliminating certain kinds of weeds that other kinds which are tolerant or resistant to the herbicide rapidly fill in the space vacated by the susceptible weeds.

Some disruption of the environment has occurred from the use of pesticides; however, the major concern is what might happen in the future with the continued use of persistent pesticides. Will the chemical levels reach a point where many facets of the environment will be adversely affected? This, plus the accidental poisonings that occur each year, has prompted needed changes in the registration, use, and handling of pesticides and in carrying out pest control programs in general.

Societies' demands

Society appears to have certain demands pertaining to the control of pests. Basically, they are:

1) Highest priority is given for control of pests to protect the health of people and animals. It is not necessary to describe the black plague epidemic that killed approximately one-third of the people in Europe (two pests were involved, rats and fleas); or the millions of people that die throughout the world each

ROCKY MOUNTAIN WOOD TICK

year from malaria and yellow fever (mosquitoes). Local outbreaks of encephalitis (mosquitoes) and Rocky Mountain spotted fever (ticks) caused considerable concern and anguish in communities throughout the United States. Control of rabies: there are many cases each year of rabies transmitted to dogs and even to people through the bites of bats, skunks, and other animals which serve as a reservoir of the virus.

2) Protection of food and fiber from pests. The need for all available food and fiber points up the importance of this demand. Millions of dollars worth of food and fiber are lost annually to insects, mites, diseases, birds, rodents, and weeds during production with losses continuing during processing and storage.

3) Alleviation of nuisance pests is a third demand with a somewhat lower priority. No one likes to be pestered by flies, gnats, cockroaches, etc., flying and crawling about our homes. Nor do we like to have pigeons roosting on buildings and layering the sidewalks below with droppings.

4) Maintenance of a viable environment. This lesson, in fact the entire course, is concerned with the control of pests while maintaining a livable environment. In other words, do what is necessary to keep pests under control without polluting or seriously damaging our surroundings.

Pest management employs many control methods

Future success in managing pests will depend greatly upon how well we use both old and new control methods which are successful and not destructive to our surroundings. Numerous safe and satisfactory methods are available for controlling pests and each method can contribute to the prevention or reduction of kinds and numbers of pests. Therefore, the use of combinations of several effective and practical methods — including cultural, chemical, and resistant varieties — seems to be a logical approach to handling most plant pest problems.

NO ONE LIKES TO BE PESTERED

An overview of pest control

Some of the methods or means by which pests are kept in check are summarized below:

1) Natural control is any condition that slows down reproduction and growth of a pest organism and cannot be altered at will by man. The weather, especially temperature and moisture, is the major natural control force. It can encourage or discourage insect and plant disease outbreaks.

2) Cultural control is any manipulation that tends to disrupt the normal association between a pest and its host. Examples are cultivation for weed control and control of planting dates. Planting wheat after the fly-free date has been a standard practice for many years to reduce Hessian fly damage.

3) Mechanical control is the use of special equipment. The results are immediate and positive. A classic example of this

method is the fly swatter.

4) Legal (quarantine) control uses procedures that resist the introduction or spread of a pest into an area; such as, active trapping, inspection, and abatement such as the cooperative efforts between federal and state agencies in the gypsy-moth program.

5) Biological control is the direct or indirect use of living organisms to reduce the number of pests below a level of economic importance. Examples are hawks catching mice, lady beetles eating aphids, and one fungus antagonistic to another.

6) Chemical control is the use of chemicals to suppress a pest population. We normally think of chemical control as toxic materials that kill weeds, insects, rodents, and plant-disease organisms; however, this is only part of the chemical arsenal. There are also chemical repellents, attractants, sex lures, hormones, growth regulators, etc.

Pesticides usually provide only temporary reduction of pest numbers but often this is sufficient to save a crop or commodity from destruction. Pesticides are also sometimes essential to sufficiently lower pest numbers so biological or natural control forces can be of significant value. Pesticides involve certain risks to nonpests and beneficial organisms. Some pesticides can be a potential hazard to our surroundings; highly toxic or persistent chemicals are most apt to be damaging to man and the environment. However, pesticides are essential in combating many pest problems because they usually provide quick results, can be applied when and where needed, are usually readily available, and are economical under most conditions.

7) Genetic control is control through the use of resistant or tolerant varieties.

8) Integrated control is the combination of cultural, mechanical, biological, and chemical control in a compatible relationship and forms the basis for a total pest management plan. An example would be the control of the alfalfa weevil on alfalfa. If weevil damage becomes serious, the field is sprayed with a selected pesticide that will bring the pest numbers back down to a tolerable level, but in so doing will have minimal adverse effect on the weevil parasites.

9) Pest management is the use of a number of effective control measures coordinated for overall crop or animal protection so as to reduce pest numbers to a low enough level where they cause little economic damage.

Pest management

Comprehensive pest management can work. There are three major goals:

1) To reduce the amount of pesticide being released into the

COSTS CAN BE REDUCED

environment. This does not mean the use of pesticides should be stopped; however, those pesticides used should be carefully selected for each situation. The risk-benefit equation for each situation must be carefully weighed and when pesticides are needed only those that will do the job with the minimum of pollution or disruption should be used.

2) To reduce or at least not greatly increase the cost of controlling pests. Cost figures compiled from pest management programs now in progress indicate that the number of pesticide applications can be reduced, thereby lowering both the amount of pesticides used and cost of application.

3) To produce a good yield of acceptable quality, in the case of a crop, or to give acceptable results in other situations.

It is an obvious conclusion that any pest control program that reduces pollution resulting from persistent and toxic substances and lowers or at least not greatly increases the cost of doing the job with acceptable results will be quickly adapted. However, as systems of pest management become more diverse and technical problems become more complex, more technical knowledge is needed.

Experience with cultural, mechanical, chemical, biological, and other methods of controlling pests has shown us that each method has limitations in its effectiveness and practicality. Limitations include the time available to obtain control (the crop may be destroyed before the job is done), manpower available, costs, etc. Another problem that must be considered is the expertise and time needed for proper management of such programs. The money saved on reduced spray applications and lower pesticide use may be needed to pay for technical knowledge of the program.

Lesson 1

INTRODUCTION TO PEST MANAGEMENT

Answer the following questions True (T) or False (F).

____ 1) Insect pests and plant diseases have been with us from the dawn of time.

____ 2) The big famine in Ireland resulting from destruction of the potato crop was caused by the angry God, Robigus.

____ 3) Destruction by predators, insects, and weeds was understood before destruction by plant diseases.

____ 4) The very first pest control measures used chemical pesticides.

____ 5) All pesticides are extremely hazardous to the environment and should be completely banned from use.

____ 6) Some major problems arising from the use of pesticides are a result of persistence of the the chemicals.

____ 7) Pesticides have never caused any disruption of the environment and there is absolutely no need for any federal or state laws to control their sale and use.

____ 8) The lesson listed four demands of our society in reference to controlling pests. Considering the advanced state of agricultural technology, these demands are no longer valid.

____ 9) Any pest can be easily controlled by a single method.

____10) Management of pests involves the use of a number of effective control methods.

Circle correct answer:

11) One of the earliest pesticides was:
   A) Maneb
   B) DDT
   C) Parathion
   D) Sulfur
   E) None of these

12) Chestnut blight was devastating in the United States because:
   A) The climate was especially favorable for the fungus
   B) The American chestnut lacked any resistance
   C) The prevailing easterly winds spread the fungus spores
   D) The chestnut was an important source food for wildlife
   E) None of these

13) Pesticide resistance becomes a problem when:
   A) A few resistant individuals of the target pest species reproduce and predominate in a population
   B) When the pesticide induces a so-called tiger effect
   C) When the pests decide they like to feed on the pesticide
   D) The pests won't eat the bait
   E) None of these

14) An example of ***cultural*** control of pests is through:
   A) Lady beetles
   B) Resistant varieties
   C) Cultivation
   D) Pruning
   E) None of these

15) One of the drawbacks in utilization of the new systems of pest management is the increased level of:
   A) Technical knowledge needed
   B) Shortage of pesticides
   C) Cost of fertilizer
   D) Shortage of application equipment
   E) None of these

Answers
1 T
2 F
3 T
4 F
5 F
6 T
7 F
8 F
9 F
10 T
11 D
12 B
13 A
14 C
15 A

Lesson 2

MANAGEMENT OF COMMON INSECTS AND MITES

In the eastern United States, there are approximately 300,000 different kinds (species) of insects, mites, spiders, and related arthropods. No one can be expected to recognize all these species, and no one needs to — there are only about 100 species that are of economic importance on an average farm. When you consider the different insects and mites that attack animals, damage crops, eat stored foods and feeds, ruin buildings, and pester people, the number is small and many of these pests can be readily recognized and identified.

This vast number of insects, mites, spiders, ticks, etc., can be divided into three categories according to their economic importance:

1) The first and largest category includes those species which are of only minor importance to man. Approximately 99 percent of the species fall into this category and are the ones that "take up space" and supply food for birds, fish, and other organisms.

2) The second rather small but important category includes the beneficial insects and mites. In this group are the parasites and predators that feed on destructive insects and weeds; for example, lady beetles, ground beetles, tachinid flies, and numerous tiny, parasitic wasps. Also in this category are the pollinating insects, such as bumblebees and honeybees. Without the pollinators you would be without some fruits, vegetables, and forage.

LADY BEETLE

3) The third category is for the destructive insects — the category that usually comes to mind when insects are mentioned. However, this category fortunately includes the smallest number of different species. In this category are the caterpillars, beetles, plant bugs, and aphids that destroy crops; the mosquitoes, lice, and flies that attack animals; and the weevils, termites, and borers that destroy stored products and structures.

TACHINID FLY

Diagnosis of insect problems

The way in which an insect feeds or inflicts damage to a plant or animal, thereby producing typical symptoms, often provides a reliable clue to the identification of the pest.

Damage to plants is found in many ways, with all parts of the plant subject to attack.

1) The most obvious damage is the destruction or actual eating away of the leaves and foliage. This damage is usually done by either the larvae or caterpillars of moths and butterflies or by adult beetles and their larvae. The imported cabbage worm that chews up cabbage leaves and the armyworm which frequently eats the leaves of corn and small grains are examples of caterpillars that are destructive to the foliage.

2) Another easy-to-see damage occurs to fruits or seeds. The

EUROPEAN CORN BORER

SPITTLE MASS CONTAINING SPITTLEBUG NYMPH

OX WARBLE ADULT

AND LARVA

worm in the apple is probably the immature stage or larva of the codling moth; the fat, white worm in the plum is the larva of the plum curculio; and the active, dirty-white worm found in bell peppers is probably a larva of the European corn borer.

3) Some insects do their damage by working their way into the stem of the plant, thus weakening the plant internally. Common examples of this type of insect are the European corn borer, the common stalk borer, and apple tree borer. Infested stalks often wilt or may break due to the weakened stems.

4) There are usually several symptoms caused by sucking insects, such as aphids, spittlebugs, leafhoppers, whiteflies, and scale insects. Aphids, whiteflies, and soft scales not only weaken the plant but they also excrete honeydew which drips onto lower parts of the plant. A black sooty fungus soon develops in the honeydew giving the plant the appearance of being dusted with soot. Spittlebugs can easily be identified by the small masses of spittle-like bubbles that surround the feeding nymphs. In the feeding process of leafhoppers, some of the plant's food-carrying channels are blocked off resulting in stunted growth or dead areas of the infested leaf. Some of the species of aphids and leafhoppers are also known to be carriers of some plant diseases.

5) Some insect damage is found when young plants are cut off near ground level. This symptom is usually associated with cutworms, the larvae of a group of moths.

6) Among some of the most difficult insect pests to identify by plant symptoms are those that damage the roots and underground portions of the plant. Root damage causes various symptoms depending upon the plant species and weather conditions. Most plants with root damage show lack of vigor and off-color. Alfalfa plants with damaged roots may show excessive heaving during the winter, whereas corn may fall over and then "goose neck" as the plants right themselves. Symptoms in other kinds of plants are usually less obvious. Some of the common soil pests are the seed and root maggots (larvae of certain kinds of flies), northern corn rootworm (larvae of a small yellowish-green beetle), wireworms (larvae of click beetles), and white grubs (larvae of June beetles and Japanese beetle).

Insect pests of livestock are primarily of four types:

1) Those which suck blood, such as the biting flies and biting lice;

2) Those which pester and annoy animals, such as face flies and house flies;

3) Those which destroy tissue and act as a parasite within the body of the animal, such as ox warble of cows, nose bot of sheep, and bot fly of horses; and

4) Scab mites, which feed on blood and lymph near the skin surface, with the affected skin showing as rough and scabby

with little or no hair remaining.

SCAB MITE

Planning pest control programs

In the discussion of insect pest management, only the beneficial and the destructive insects will be considered, since they are the ones that are of direct importance to you. In developing a pest control program for a particular crop or type of livestock, follow a few basic steps in planning

Step 1.

Identify the insect or insects involved. The major insect pests to farm crops and animals are not very numerous and can soon be recognized. You will seldom have any trouble identifying the common insect pests that occur in your area, such as the European corn borer, alfalfa weevil, Colorado potato beetle, striped cucumber beetle, cattle lice, etc.

JUST AS I SUSPECTED

It is the unusual insects, or those that are new to your area, that will be most difficult to identify and for which additional help may be needed. You can get assistance from your local county Agricultural Extension Agent. He will either identify the pest or contact a university specialist for the answer. There are also a number of competent fieldmen affiliated with agricultural supply dealers that may help you in insect identification.

The college of agriculture's cooperative Extension service, one of which is located in each of the 50 states, prepares publications on most of the major pests affecting crops and animals in each state. These publications are available through the county agent's office near you. Their office is listed under "Government Agencies" in your telephone book.

The important point is to make a correct diagnosis of the cause of the problem – and the pest – before attempting any control measures.

Step 2.

Select the appropriate method or methods of control. This can be a rather easy process or a very complex one that should be planned a year or more in advance. Perhaps the best way to understand what types of planning are involved is to take the example of the major insect control problems on two farm crops. Alfalfa has rather complex pest problems, while those of wheat are relatively few.

PEA APHID

First, identify the problem by listing the major insect pests of alfalfa in the Mid-Atlantic States. The most destructive pest over a period of years has been the potato leafhopper. A second insect pest is the alfalfa weevil. Others include the alfalfa leaf blotch miner, spittlebug, and pea aphid. Five insects are listed, but the latter three have not caused any major losses to the crop. The alfalfa weevil appears to be stabilized in eastern United States with high populations and serious damage limited to

localized areas. Parasites are present throughout the area. The leafhopper's invasion of alfalfa fields is unpredictable. Infestation levels are seldom uniform among fields and infestations vary widely among localities within a state, as well as from year to year. Their damage to the plants is not obvious until the plants turn yellow and become stunted — by this time it is too late to protect the crop. The new seedlings and the second and third cuttings are most likely to be damaged.

What types of control measures can be used to manage these five pests to the best advantage? Natural methods are always available and result in ups and downs of pest numbers, but they cannot be completely controlled and therefore are never reliable.

How about the cultural controls? Harvesting the first cutting relatively early (bud stage to early bloom) will save many fields from severe losses due to alfalfa weevil. There is also a possibility that properly timed harvesting offers effective control of the alfalfa leaf blotch miner. There is a variety with resistance to weevil but none are available for the leafhopper.

Biological controls are sometimes effective. For example, a fungus will normally keep the pea aphid in check. Several parasites of the alfalfa weevil are established and are helping hold down this important pest. There are no known biological agents that effectively control the leafhopper.

Chemical control (insecticides) is available for all pests. *Several questions must be answered before a pesticide should be used:*

1) Is it needed?

2) Will it disrupt the parasites and other beneficial organisms in the field? What about the alfalfa weevil parasites — can they survive a spray application? Which insecticides will control the pests without injuring the others?

3) When should spray be applied if it is needed?

4) How many acres need treatment? and

5) Which insecticides will do the best overall job without leaving any residue on the forage when harvested?

ALFALFA WEEVIL

Most of the varieties of alfalfa planted in the Middle Atlantic States are not resistant to alfalfa weevil. Therefore, you must be alert and check for weevil larvae and their damage. A good time to start is in early April, or when the new crop is about 10 inches high. Are larvae present and is there enough damage to warrant spray protection? This is often a difficult question to answer.

How many insect pests per plant or how much damage can appear on a plant before chemical protection is needed or before it is financially justifiable? The term used to describe this situation is *economic threshold*. After many years of research

THE ECONOMIC THRESHOLD

and experience, the economic threshold for alfalfa weevil larvae on alfalfa is when 75 percent of the tips of the plants show slight feeding damage. If this occurs two weeks or more before harvest, spray with a registered insecticide. If this level of injury is reached a week or less before harvest, then consider harvesting as soon as possible instead of spraying.

POTATO LEAFHOPPER

The leafhopper is a major alfalfa pest and moves into an alfalfa field in early June. Unfortunately, the alternative control measures are limited to natural and chemical. How can this be handled? In developing a means for combating a specific pest, think of as many alternatives as possible. After careful study, choose the one most suitable to your overall operation. However, don't overlook other pests. You must realize a poorly timed application or improper insecticide selection might affect weevil parasites.

These are three obvious alternatives that alfalfa growers can select from to control leafhoppers. As expected, each alternative has its advantages and disadvantages. Keep in mind that this approach to the solution of the leafhopper problem is an approach that can be used to try to solve any pest problem of any crop.

Alternative No. 1. This alternative is to do nothing. The grower will probably inquire from his neighbors why his alfalfa was yellow and stunted last summer and why his alfalfa stands fade out in a few years time. He may even go so far as to talk about treating for leafhoppers, but when the time comes for action, the alfalfa looks fairly good so he does nothing.

THE DO NOTHING ALTERNATIVE

Advantages:

a) This alternative saves the grower the cost of a spray application.

b) There will be no hazard to beneficial parasites or predators and no chance of pesticide pollution of the environment.

c) If the leafhopper population is nil, the alfalfa will escape damage.

Disadvantages:

a) He has a good chance of losing a substantial quantity and quality of his production.

b) Lack of treatment, if needed, will result in weakened plants and fading out of the stand.

c) Lack of leafhopper control could put the grower out of alfalfa production.

Alternative No. 2. This alternative is one of leafhopper *prevention*. This grower follows a definite spray schedule regardless of the leafhopper population in the fields. He sprays the second and third cuttings on all established stands whenever the new growth is four inches tall. All new seedlings get sprayed on the 10th of June, July, and August.

HIGH IN COST

Advantages:

a) Such a schedule will practically eliminate leafhopper damage and will provide an opportunity for a potentially high yield.

b) Absence of leafhoppers would eliminate their impact on the longevity of the stand.

c) The grower should have ample time to secure spray material and build spraying time into his work schedule.

d) A preventive schedule will take the guesswork out of the grower's leafhopper problem.

e) The schedule might control other pests that are present in the field at the particular time sprays are applied.

Disadvantages:

a) This leafhopper spray schedule will be high in cost.

b) Some of the spray applications would almost certainly not be needed.

c) The additional unneeded applications increase the hazards to beneficial species without any resulting benefit. Heavy concentrations of insecticides could also contribute to the disruption of the balance of alfalfa weevil and other pests.

d) Fixed-spray schedules that call for the application of an insecticide, whether needed or not, definitely increases the opportunity of the pest to develop resistance to the insecticide.

Alternative No. 3. This alternative approaches the principles of pest management. The grower monitors leafhopper populations in his new alfalfa seedings and in the second and third cuttings in each field. Monitoring is discussed on page 17.The grower uses a registered insecticide only on those fields when and where leafhopper numbers warrant their use.

POTATO LEAFHOPPER NYMPH

Advantages:

a) This type of control program practically eliminates leafhopper damage and provides opportunity for a potentially high yield.

b) The leafhopper damage impact would be eliminated on the longevity of the stand.

c) Unnecessary spray applications would be eliminated resulting in less use of insecticides and application costs.

d) Good monitoring methods pinpoint fields that need protection and give optimum timing to apply the insecticides.

e) Since all fields will not need spray protection, the amount of insecticides used on the farm will be reduced and a reservoir of beneficial insects will be maintained in the untreated fields on the farm.

Disadvantages:

a) Expertise in monitoring fields and understanding economic thresholds must be developed.

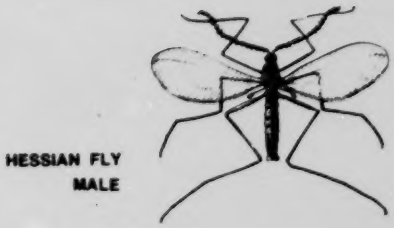
b) Most, if not all, of the costs saved from fewer spray applications can be spent on monitoring and management of the program.

c) Buying insecticides and planning the work schedule for spraying will be uncertain and on short notice.

d) Some growers will be reluctant to adopt this alternative due to a lack of confidence in their management knowledge.

Monitoring and economic thresholds. Monitoring a field for leafhoppers is no more than getting into the field and observing how many leafhoppers are there at any given time. Check new seedings regularly, at five-day intervals, starting in early June. Check second and third cuttings regularly when the new growth reaches 3 to 4 inches. An insect net is used for the monitoring. Make ten sweeps of the net through the alfalfa in ten different spots of each field and then see what you captured in the net. An average of *one* or *more* potato leafhoppers per sweep of the net (one leafhopper per sweep is the economic threshold on alfalfa) or, ten or more in ten sweeps indicates there are enough leafhoppers in that particular field to warrant the application of an insecticide.

As you have just learned, the planning of an insect control program for alfalfa is rather complex. Fortunately, there are a few crops that require little planning to combat their insect problems. In contrast to alfalfa, let's take a look at the insect pests of wheat. In the Mid-Atlantic States, the major insect pest of wheat is the Hessian fly. Minor damage comes from stem sawfly, jointworm, stem maggot, and occasionally chinch bug and armyworm.

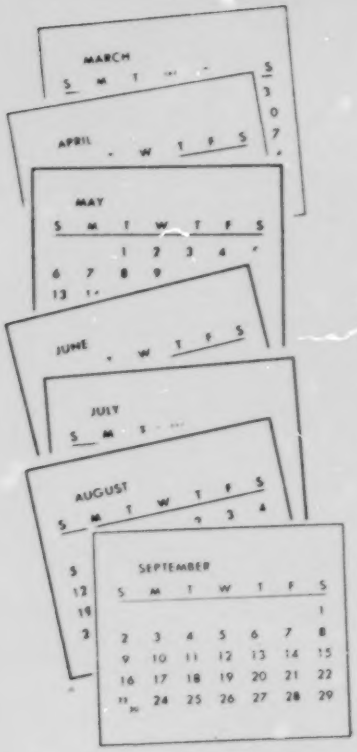


There are two effective and practical control measures for Hessian fly. First, several good resistant wheat varieties are available. By planting a resistant variety, the Hessian fly problem is solved. There is also a second control measure to be used if a susceptible variety is desired and that is to plant after the "fly-free" date. If planting is delayed until late September or early October (this varies with your locality), the majority of the Hessian fly adults have already emerged and died before any wheat plants are available on which to lay their eggs. If it is necessary to plant a susceptible variety before the fly-free date, chemical control can be used.

The selection of the appropriate methods can be simple or complex depending on the insect pests and the crop or animals involved. Similar procedures for selecting appropriate insect control methods, as discussed in the examples for alfalfa and wheat, can be modified and used for most crop or animal insect pest programs.

Step 3.

This step is the proper use of the selected control methods. Controlling insects costs money, so you must get the best results possible out of the control measures you use. To do this, some basic facts about the life cycle and biology of the pest must be learned so control measures can be applied at the optimum time. Some of the things you need to know about the insect pests are:



WHEN IS DAMAGE EXPECTED TO OCCUR?

What stage or stages of the insect cause damage? Is it the larval stage, as in the European corn borer and cabbage worms; is it the adult stage, as for corn flea beetles, striped cucumber beetles, and house fly; or is it both the immature and adult stages, as in Colorado potato beetle, potato leafhopper, and asparagus beetles?

When is damage expected to occur? Is it in June from an insect that has only one generation per year, such as the northern corn rootworm whose larvae damage corn roots? Is it in June and again in August by an insect that has two generations per year, such as the European corn borer? Or can you expect a problem all season long from a pest that has many generations per year, such as the house fly, San Jose scale, and aphids?

When insecticides are selected as the appropriate control method, immediate consideration must be given to their safe and proper use. Always keep in mind that insecticides are toxic to at least some insects and most of the commonly used insecticides are toxic to both destructive and beneficial kinds. In addition to being toxic to insects, insecticides are usually toxic to man, domestic animals, and wildlife. Insecticides vary considerably in their toxicity (this is discussed in Lesson 6).

Since most insecticides are potentially hazardous to bees, parasites, and other beneficial insects, applications should be made either when such insects are not active or should be made in such a manner that the insecticide will have minimum effect on the beneficial organism.

> For example, don't spray fields if the plants are in full bloom unless it is absolutely necessary to save the crop from destruction. If spraying must be done, then apply the insecticide late in the day after foraging bees have left the field.

DON'T SPRAY FIELDS IF THE PLANTS ARE IN FULL BLOOM

Avoid the use of highly toxic insecticides near pastures and around buildings where air currents may drift some of the insecticide onto animals or onto forage in nearby pastures.

How, where, and when should the insecticide be applied to get the best results, to be practical and economical, to avoid contamination of food, feed, water, etc., and to have the least adverse effects on the environment? For example, the use of a registered insecticide applied as a granular formulation to the soil at planting time provides effective control of corn rootworm and is both practical and economical to use. By using a granular formulation, the toxicity exposure to the operator is minimal and by applying the insecticide into the soil there is little chance of immediate environmental pollution. Attempting to control the corn rootworm adult beetles in August and September as they collect on the corn silks, with spray applications of an insecticide is not practical unless they interfere with pollination. As you can see, such a use of an insecticide will not offer effective control of the problem because it is applied too late to protect the growing crop and will not kill enough of the

beetles to avoid damage next year. It is neither practical nor economical due to the height of corn and number of applications necessary. The insecticide will be hazardous to bees since it will be applied when the corn plants are shedding pollen and bees work corn during this time. Drift and air pollution from the sprayed insecticide are greater than from the soil application.

SEE TO IT

The proper use of the selected control method can be summarized with the word, "SEE." See to it that *Safety* precautions to the operator, animals, and environment are followed. See to it that the method is used *Effectively* to get the best control possible. See to it that the control method used is *Efficient*. You can't spend more for pest control than the value of the commodity being protected.

Step 4.

A final and obvious step is to measure the results. It is usually fairly easy to determine if the pests were satisfactorily controlled, if the measures were only partially effective, or completely ineffective. Any undesirable side effects resulting from the control measures should be noted and evaluated. Some undesirable effects may show up promptly while others may not surface for several years.

With constant evaluation of your insect control programs, you can sort out those that are not effective, economical, too hazardous, or even detrimental.

Lesson 2

MANAGEMENT OF COMMON INSECTS AND MITES

Answer the following questions True (T) or False (F).

____ 1) All insects, spiders, mites, and ticks are bad and should be killed.

____ 2) Some insect damage to crops can be identified by the symptoms.

____ 3) It is often difficult to diagnose damage caused by soil-infesting insects.

____ 4) There are no destructive insects that attack animals.

____ 5) Bumblebees and honeybees are necessary for the satisfactory production of some fruits and vegetables.

____ 6) You should use the same control methods regardless of what the insect pest might be.

____ 7) All application methods of pesticides are equally harmful to the environment.

____ 8) It is a good idea to consider the advantages and disadvantages of various control methods before selecting the one to use.

____ 9) It is not always economically justifiable to spray a crop. If the damage level or insect pest numbers are below the economic threshold, control measures are not warranted.

____10) One should always make a close evaluation of the pest control measures used and discard any that did not work effectively, was detrimental, or too costly.

Circle correct answer:

11) Most insect species are:

A) Beneficial
B) Destructive
C) Of little or no importance
D) Beautiful
E) None of these

12) You should start control measures for a pest:

A) When you see your neighbor spraying
B) Just after a rainstorm
C) After you have identified the cause of the problem and the pest has reached the economic threshold
D) When you have the money to purchase the needed material
E) None of these

13) Of several alternatives available for controlling insects, the one most likely to give the desired results with the least amount of pesticides needed is:

A) To keep a close check on the insect population and apply control measures only when and where they are needed
B) To use a preventative spray schedule on a definite time schedule
C) To do nothing, just hope for the best
D) Consult your pastor
E) None of these

14) To reduce insecticide hazards to pollinating bees:
   A) Use only half the dosage of insecticide called for on the label
   B) Do not apply insecticides to crops that are in bloom or at least choose the time of day when bees are not active to apply insecticide
   C) Don't spray, let the insect pests destroy the crop
   D) Spray before bees emerge in the spring
   E) None of these

15) Avoid the use of highly toxic insecticides near pastures and buildings because:
   A) They stain the paint and rust the fences
   B) Some of the material may drift onto animals or onto forage in nearby pastures
   C) The animals may become frightened when a sprayer is operating nearby
   D) The neighbor's wife may be allergic to them
   E) You may alarm your songbirds

Answers
1 F
2 T
3 T
4 F
5 T
6 F
7 F
8 T
9 T
10 T
11 C
12 C
13 A
14 B
15 B

Lesson 3

WEED CONTROL AND HERBICIDES

Any plant can be considered a weed if it grows where you don't want it to grow. Some crop plants may be considered weeds. Volunteer small grain, after harvest in the late summer, may be a severe problem if the field has been seeded to a legume or grass forage. One of the worst weeds in soybeans — when soybeans follow corn in the rotation — is volunteer corn.

Pigweed, lambsquarters, yellow foxtail, giant foxtail, and barnyard-grass are common weeds. In different areas of the country they may have different names; therefore, almost all plants — common or uncommon — have now been categorized in a plant classification system and given a scientific name to identify them anywhere in the world.

From this classification, weeds can be identified and herbicides selected and used, if necessary, for proper control.

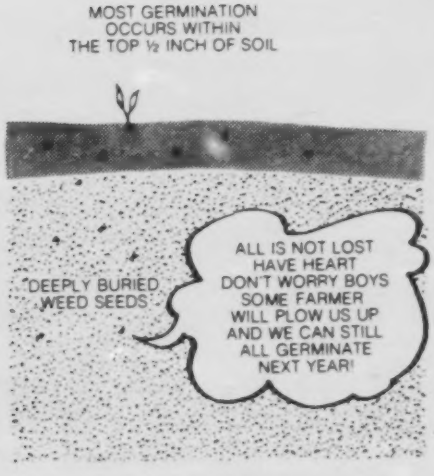
ANY PLANT CAN BE CONSIDERED A WEED IF IT GROWS WHERE YOU DON'T WANT IT TO GROW

Types of weeds

Weeds may be classified into four major groups — summer annuals, winter annuals, biennials, and perennials — which simplifies understanding the weed control program for each group. The difficulty in controlling weeds is understanding the control program for each weed or group of weeds.

1) Summer annual weeds grow every spring or summer from seed; they produce seed, mature, and die in one growing season.

Seed from most summer annual weeds germinate during a two-month period during the spring (May and June in Pennsylvania). Then the seed lies dormant until the next spring. There are usually a few seeds of every species that germinate during summer or fall but seldom in numbers equal to the spring flush. Of the millions of weed seed lying beneath every square foot of land, probably not more than 5 percent will germinate in any growing season. Summer annual weeds are the greatest problem in spring when annual crops are planted and new seedings of perennial crops are made because seed germinates most readily in disturbed soil.

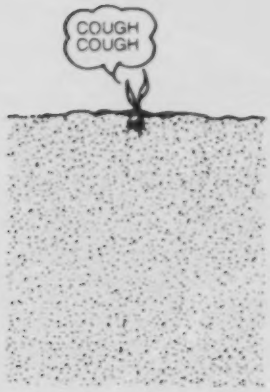

MOST GERMINATION OCCURS WITHIN THE TOP ½ INCH OF SOIL
DEEPLY BURIED WEED SEEDS
ALL IS NOT LOST HAVE HEART DON'T WORRY BOYS SOME FARMER WILL PLOW US UP AND WE CAN STILL ALL GERMINATE NEXT YEAR!

One of the simplest methods of solving a weed problem is to avoid it. Mid-summer legume and grass seedings and normal fall seedings of winter wheat or barley are seldom bothered with summer annual weeds. A second solution is to plant the crop in early spring before most of the weed seed germinates, a practice successful with normal plantings of spring oats.

A crop rotation of perennial crops, such as legumes and legume-grass mixtures where the soil is not tilled in the spring, greatly reduces the numbers of summer annual weed seed that germinate. Since these areas are usually grazed or cut for hay, weeds that do germinate do not go to seed. For that portion of the rotation — when small grains or forages are planted — most summer annual weeds are controlled naturally by unfavorable conditions for germination in the spring and by good crop

NIP THEM IN THE BUD!

SEEDLING WEEDS ARE THOSE MOST EASILY CONTROLLED BY HERBICIDES



competition at the time summer annual weed seed would normally germinate.

Certain annual crops such as corn, soybeans, and sorghum must be planted after the soil is warm. Since the life cycles of summer annual weeds are synchronized with these crops, there is commonly a weed problem and a need for herbicides. Some weeds can be controlled by picking the right hybrids, using good fertility, and planting a good population at the right time. For those weeds which cannot be controlled by normal cultural practices, use herbicides.

Summer annual weeds are easily controlled by "pre-emergence" herbicides. These herbicides are applied before the weeds and crops (corn, soybeans) emerge. Depending on how the herbicide works, the weed seedling is killed before or soon after it emerges. None of the herbicides used for weed control on cropland will kill dormant weed seed except methyl bromide.

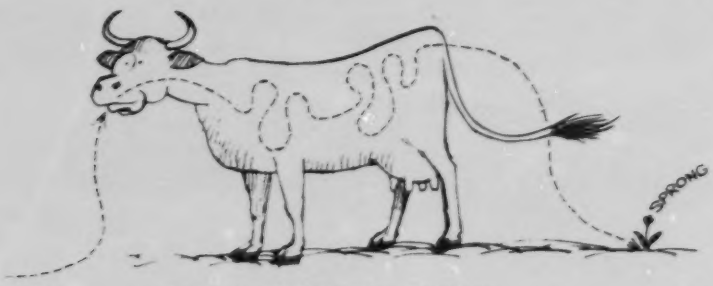
If weeds are not controlled in the seedling stage, they can usually be controlled with "postemergence" herbicides which are applied after the weeds and most crops have emerged. The larger the annual weeds, the more difficult they are to control. Therefore, you may need more herbicide or a "hotter" herbicide for effective control with a greater chance of injuring the crop. Therefore, postemergence treatments should be used in emergencies where previous efforts to control the weeds have failed. Some herbicides that are absorbed only through the foliage can only be applied after the weeds have emerged but these must be matched to the crop in order to prevent crop injury. Although the herbicide may be selective for the crop and give total control of emerged weeds, competition during the first 2 or 3 weeks of crop growth may be enough to reduce crop yields.

Spraying summer annual weeds about a month before frost is unnecessary, since ripe seed will probably already have been produced and the remaining vegetation will usually be killed by the first killing frost.

2) Winter annual weeds come up in late summer or fall from seed and mature and produce seed the following spring or summer.

Seed from most winter annual weeds are dormant in the spring but germinate in the late summer or fall. Some species, such as common chickweed, can germinate under snow cover. These weeds start growth at the first sign of spring and many species bloom and produce ripe seed by mid-May or June. This means that some weeds can reseed themselves before land is prepared for late planted crops, such as soybeans or sorghum. The growth cycle of winter annuals is also synchronized with fall-sown small grains, such as winter wheat or barley. There are several species, such as field pepperweed, which are so closely

synchronized that the weed produces ripe seed at the same time that the grain ripens and the weed seed is thrashed along with the grain. Unless the grain is cleaned, the weed seed is fed to cattle and spread back on the field in the form of manure. Weed seed in grain used for seed is seeded along with the grain to give an immediate weed problem.



THE PATH OF THE IMMORTAL WEED SEED

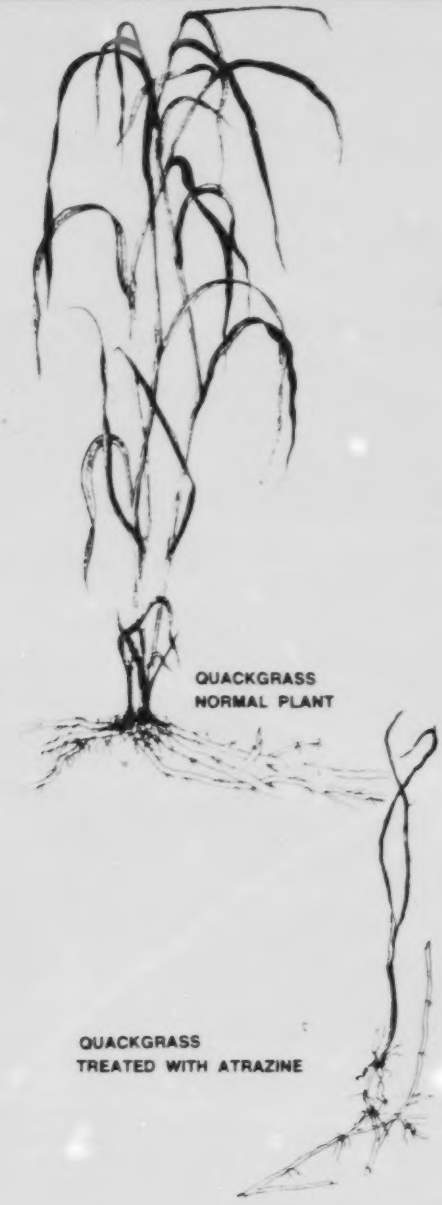
Competition from the crop should be the first weed-control weapon. Use a seeding rate which gives a good stand and fertilize to obtain maximum yields which should also supply maximum competition. Those weeds not controlled by good management practices have to be controlled by herbicides.

3) Biennial weeds grow from seed anytime during one growing season. They normally produce a rosette of leaves close to the soil surface the first year; then flower, mature, and die the following growing season.

Biennial weeds, though relatively few, may become established from seeds anytime during the growing season. Wild carrot and bull thistle are two of the most common Pennsylvania biennial weeds. A true biennial never produces flowers or seeds the first year but forms a rosette of leaves that usually lie close to the ground.Such weeds are well adapted to lawns, pastures, hay fields, and orchards where grazing or mowing removes very few of the rosette leaves. Consequently, growth and energy storage in the roots or crown continues until a killing frost. This large amount of stored energy supports spring growth, ahead of other pasture and forage species. If biennial weeds are not controlled before this time, there are no forage species that will crowd them out. Unless the flower stalks are mowed off or plowed under, they will flower and produce seed. The plant dies after the seed matures.

BULL THISTLE

The best time to control biennial, as well as all weeds, is in the seedling stage. This is the only time that the crop can compete with and possibly control weeds. Once established, the biennial weeds can only be controlled by herbicides. Soil-applied herbicides are ineffective because these herbicides leach only deep enough to contact a small portion of the weed's large and deep root system. As a result, not enough herbicide is absorbed to kill the weed. Foliar-applied herbicides, such as 2,4-D, which are absorbed through the foliage and translocated within the plant



ATRAZINE
BLOCKS
PHOTOSYNTHESIS

to the root system, kill the whole plant. However, since these herbicides are effective on most broadleaved species and are selective for grassy species, they cannot be used where you may want to save certain broadleaf species, such as legumes in a legume-grass pasture. They can be used very effectively on pure grass areas such as lawns, orchards, and some pastures.

4) Perennial weeds become established by seed or by vegetative parts, such as root stocks or rhizomes; once established, they live for more than two years.

Since perennial weeds live indefinitely, their persistence and spread is not as dependent upon seed as with the other three weed groups. Seed is the primary method of introducing these weeds into new areas; however, perennial weeds are often spread during soil preparation and cultivation. Most perennial weeds that spread by rhizomes or root stocks will spread in circular patches if left undisturbed. In cropped fields, patches of quackgrass, Canada thistle, and Johnsongrass spread in oblong patches in the direction the field is worked.

Perennial weeds grown from seed are no more difficult to control than any other kind of weed coming from seed, but once established, perennial weeds are the most difficult to control. They compete with any crop, especially row crops where competition between rows is not too great. Perennial weeds also get an early start in the spring and compete with perennial crops, such as alfalfa and other forage species.

Although perennial weeds are difficult to control, they are more easily controlled at certain times of the year.

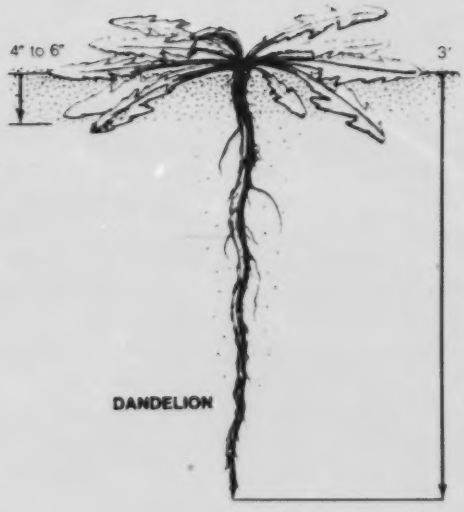
One of the best times to control perennial weeds is in late summer or early fall before they have a chance to build up large energy reserves prior to winter. Perennial weeds store energy (starch) in underground roots, stems, bulbs, and crowns during summer and fall. If these weeds are prevented from storing energy, they may not survive the winter.

To reduce weed vigor, remove top growth by heavy grazing, mowing, or by using photosynthetic-inhibiting herbicides such as atrazine. If the weed's leaves and stems are removed, no sugar and starch can be produced through photosynthesis, thus there is no buildup of energy. This is seldom sufficient to effectively control a perennial weed but it can be a good first step in weakening it so that a future treatment works better. Photosynthetic-inhibiting herbicides prevent the weed from using sunlight, although the leaves and stems may be left on the plant. The herbicide must be applied in early fall before reserve energy storage begins but not so early that the herbicide will dissipate and become inactive before frost. For most of the commonly used photosynthetic-inhibiting herbicides, such as atrazine or simazine, the active period is about 6 to 8 weeks. This is approximately the length of time, prior to a killing frost, they may be applied. Timing is critical because the weed should never have a chance to recover from the herbicide treatment.

Grazing or mowing should also be continued until frost to prevent the weed from recovering from continued defoliation.

The next best time to attack perennial weeds is in the spring. Perennial weeds are weakened by winter because part of the reserve energy is used for respiration to keep the weed alive. If a fall treatment is used, some of the weaker perennial weeds may die (winterkill) and the stronger plants be greatly weakened. Grazing or mowing can be used to defoliate these weeds again in the spring but this should be delayed until there is 8 to 12 inches of new growth.

The initial growth in the spring uses reserve energy from underground roots, stems, bulbs, and crowns which further weakens these weeds. Growth should not be allowed to continue much beyond a foot since it will start replacing some of these energy reserves, making the weed more resistant to control the longer it is allowed to grow. If a crop such as corn is planted, this would be the ideal time to plow and turn under all of the new growth so the weeds will have to use reserve energy to produce new stems and leaves. In the case of no-tillage corn where the land is unplowed, a contact herbicide, such as paraquat, may be used to "burn" off all of the topgrowth so that the weed has to start over again. Since paraquat leaves no effective residue, it is normally used with photosynthetic-inhibiting herbicides such as atrazine, simazine, or a combination of the two which inhibits photosynthesis in the regrowth and further weakens the weed. A crop compatible with the herbicides you have used should be planted to provide competition and shading during the growing season. Some perennial weeds are so vigorous that it takes a series of treatments for effective control. Make maximum use of nonchemical means to weaken weeds first, so that when the herbicide is used it gives the best control possible.

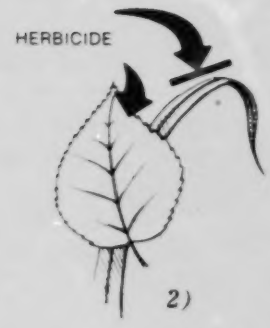


Most broadleaved perennial weeds can be most effectively controlled without photosynthetic-inhibiting herbicides which are primarily root absorbed. In general, broadleaved perennial weeds have a deep root system so that only the portion of the root system in the top 4 to 6 inches of soil can absorb a soil-applied herbicide. Since this may be less than 5 percent of the total root system, insufficient herbicide is absorbed. Therefore, foliar-applied herbicides, such as 2,4-D or dicamba, work much better on perennial weeds such as Canada thistle, hedge bindweed, horse nettle, and chicory. The best time to apply these herbicides is also 6 to 8 weeks before a killing frost or in the spring after there is sufficient growth to weaken the weed and sufficient foliage to intercept and absorb as much of the applied herbicide as possible.

Herbicide action

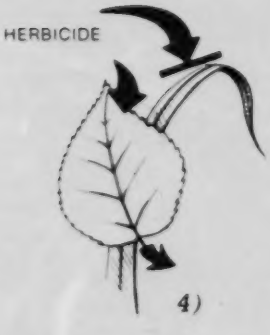
Herbicides are grouped according to the pathway by which they enter the weed and the result that is obtained.

1) Foliage – Contact – Nonselective. Herbicides applied to the weed's foliage, in the absence of a crop or directed underneath a crop, kills the foliage the herbicide contacts with little or no translocation to underground or shaded parts of the weed. Since biennial and perennial weeds normally have dormant and protected buds with stored energy in the crown or root systems that produce new growth, these weeds will recover after treatment. Small annual weeds are completely and permanently controlled. For example, paraquat, applied before a no-tillage corn planting, or used as a directed spray underneath fruit trees, will control seedling weeds. Since contact herbicides normally don't leave any residue beyond the initial contact, a residual herbicide is commonly mixed with the contact herbicide to control the regrowth of the biennial and perennial weeds plus weeds coming from seed.

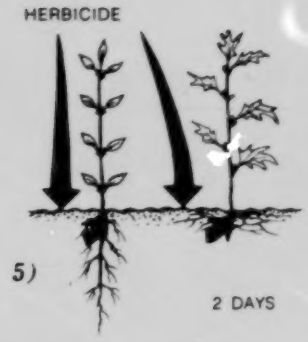


2) Foliage – Contact – Selective. These herbicides kill weeds by a contact-burning effect on the foliage. Due to differences in the waxy covering on the leaves, certain crops and weeds are not injured. These herbicides are effective only on weeds in the seedling stage and biennial and perennial weeds with dormant buds near the soil level will regrow after the foliage is killed. Generally, these herbicides are not translocated, although some may have a short residual effect in the soil. For example, Stoddard Solvent is used for annual weed control in onions; dinitro is used to control broadleaf annual weeds in new legume seedlings. Onions have a very waxy leaf that Stoddard Solvent connot penetrate.

3) Foliage – Translocated – Nonselective. These herbicides are applied to the foliage of the weeds and are absorbed and translocated throughout the plant. Since they are nonselective, they cannot be applied when a crop is present but they can be used before planting or after harvesting. For example, Amitrol T which can be used on noncrop land only is nonselective and will kill anything that is growing. Amitrol T has only a short residue so dormant weeds or weeds germinating from seed after herbicide application will not be controlled. A residual herbicide, such as atrazine or simazine, is commonly mixed with this herbicide to give continued weed control for the rest of the year.



4) Foliage – Translocated – Selective. This group includes some of the oldest and most widely used herbicides. These herbicides are applied to the foliage and are absorbed primarily through the foliage and translocated throughout the plant. They are also selective, so weeds may be treated while the crop is present with little or no injury to the crop. The best example of this type of herbicide is 2,4-D. For example, 2,4-D has many uses; it takes dandelions out of lawns or broadleaved weeds out of oats, wheat, barley, and corn. Dicamba is used for tough-to-control weeds such as thistle, common milkweed, horse nettle and hedge or field bindweed in corn, grass pastures small grains and range lands. Other common herbicides in this group



are 2,4,5-T, and 2,4,5-TP. These herbicides are used for brush control along highways, railroad right-of-ways, fence lines, and in waste areas. They will selectively remove brush without killing grass so that there are no bare areas once the brush dies.

5) Soil – Short residual – Nonselective. Only a few herbicides belong to this group. The most common, methyl bromide, is a gas at normal air temperature and dissipates into the air if the area to be treated is not covered. A sheet of plastic or gas-tight cover must be used and the gas is released under the cover. All weeds, including weed seed, are killed by methyl bromide. The cover must be kept on the treated area for about 24 hours for best results; another 24 hours is required to aerate the soil after the cover is removed. After this 48-hour period, anything can be planted without injury, making methyl bromide one of the shortest residual herbicides available.

6) Soil – Short residual – Selective. Any herbicide that is applied to the soil prior to planting a crop or immediately after planting and has a residue of less than one year belongs to this group. This includes almost all those herbicides used for weed control in vegetable and feed crops as well as for other specialized crops such as flowers and ornamentals. Since the crop is present at the time the herbicide is applied or it is planted soon after application, the herbicide must be selective and should not cause injury to the crop. These herbicides are often referred to as preplant incorporated or preemergence-type herbicides. For example, atrazine on corn, linuron on potatoes, or EPTC on ornamentals have residues that last from 6 to 8 weeks to all summer. Because these herbicides are applied to the soil, they are primarily root absorbed although some may be absorbed through the foliage if any is present at the time of application.

7) Soil – Long residual – Nonselective . Herbicides that are used to control all vegetation for as long as possible are desirable for use near parking lots, around buildings, oil storage areas, factory supply storage areas, etc. For example, bromacil and simazine, at high rates of 10 to 25 lbs. per acre, last for 3 to 5 years. Bromacil will kill brush and trees present in a treated area. Simazine will not kill deep rooted trees since it doesn't leach as readily as bromacil.

8) Soil – Long residual – Selective. These herbicides can be used only on deep rooted crops, such as fruit trees, nut trees, cane fruits, and grapes. They may be applied to the foliage of the weeds, although most of the herbicide is eventually absorbed through the root system. These herbicides have a low solubility in water and do not leach readily; therefore, they seldom get down to the root systems of the deeper rooted crop. They have a residue and will give weed control for more than one year. For example, simazine applied at rates of about 5 pounds per acre will control shallow rooted weeds without injuring deeper rooted crops. At higher rates, selectivity is lost and it becomes a nonselective herbicide.

Herbicide use

A perfect herbicide does not exist. No herbicide has the capability of controlling all weeds without injuring the crop. Since every herbicide has advantages and disadvantages, the choice of a herbicide is important.

Consider these points when you choose a herbicide:

1) Is it registered for use on the crop you want to treat? If it is, the directions for use and rate of application will appear on the label.

2) Can it be used at the stage of growth at which the crop now exists? Very few herbicides can be applied anytime during the growth cycle of a crop. One of the best examples of how stage of growth affects herbicide performance is with alachlor (Lasso). It is one of the best herbicides for annual grass control if it is applied before the grass emerges; however, it is useless if applied after the grass has emerged.

3) Can the crop be used after treatment for the purpose desired? For example, paraquat used to desiccate red clover or crownvetch before harvesting for seed will make the forage useless for feed due to paraquat residue on the forage.

4) Will it control the weeds that are giving you the most problem? Many weed control measures fail because the herbicide can't control the weeds present.

5) Will the herbicides leave a residue that might affect the crop you want to plant next in rotation? Certain herbicides classified as long residual herbicides can injure or kill sensitive crops.

For more information contact your county Extension agent or a commercial pesticide applicator.

Lesson 3

WEED CONTROL AND HERBICIDES

Answer the following questions True (T) or False (F).

____ 1) Weeds are known by the same common name everywhere in the United States.

____ 2) Only a few of the total number of weed seeds in the soil germinate in any one year so perfect weed control one year doesn't mean there won't be weeds the next.

____ 3) Rotating crops from year to year has no effect on reducing weed populations because all weeds grow equally well in all crops.

____ 4) Summer annual weeds are a problem in crops planted in the summer and fall.

____ 5) Winter annual weeds are of greatest problem in fall seeded crops such as winter barley and winter wheat.

____ 6) Perennial weed seedlings are more difficult to control than summer annual or winter annual weed seedlings.

____ 7) Weeds photosynthesize when there is green growth but photosynthetic-inhibiting herbicides prevent weeds from using sunlight.

____ 8) The best times to treat perennial weeds is in early fall or spring.

____ 9) When you choose a herbicide, it doesn't matter what crop you are raising as long as it will control the weeds you have.

____10) Herbicides that have a short residue are the preferred type if they will control the weeds that are giving you problems.

Circle correct answer:

11) Chemical control of weeds germinating from seed is most effective:
   A) In the seedling stage
   B) After 6 inches of topgrowth is produced
   C) After 12 inches of topgrowth is produced
   D) At the flowering stage
   E) At maturity

12) Which of the following is least important in selecting a herbicide?
   A) Is the herbicide registered for use on the crop you want to treat?
   B) Will it control the weeds that are of greatest problem?
   C) Is the herbicide available from the local pesticide dealer?
   D) How long will the residue last and will it affect crops you may want to plant next in rotation?
   E) Can it be used safely at the present stage of growth of the crop?

13) Established perennial weeds are more difficult to control than annual weeds because:
   A) Perennial weeds start growth earlier in the spring than annual weeds
   B) Perennial weeds are not sensitive to most herbicides
   C) Perennial weeds grow bigger than annual weeds
   D) Perennial weeds have large reserves of stored energy which will support life for awhile after treatment
   E) Most perennial weeds are grasses and not broadleaves

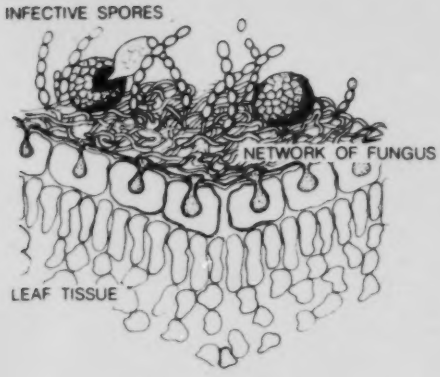
14) Biennial and perennial weeds will usually recover following treatment by:
   A) Foliage — Nonselective — Contact herbicides
   B) Foliage — Nonselective — Translocated herbicides
   C) Soil — Nonselective — Short residual herbicides
   D) Soil — Nonselective — Long residual herbicides
   E) Soil — Selective — Long residual herbicides

15) Soil — Selective — Short residual herbicides work best for control of summer annual weeds when applied:
   A) In the fall
   B) In the early spring
   C) At planting time, preemergence to the crop and weeds
   D) After crop and weeds have emerged, postemergence
   E) After the weeds reach the flowering stage

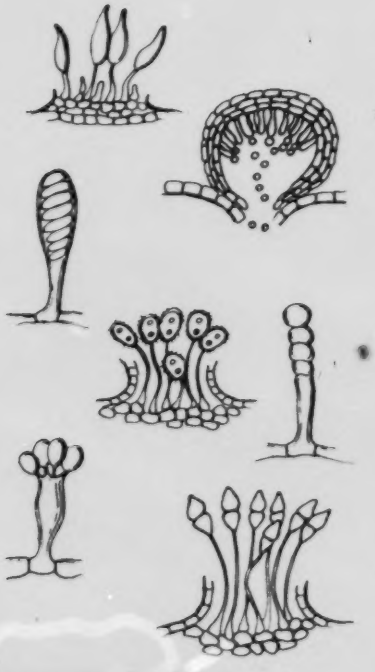
Answers
1 F
2 T
3 F
4 F
5 T
6 F
7 T
8 T
9 F
10 T
11 A
12 C
13 D
14 A
15 C

Lesson 4

PLANT DISEASE CONTROL



CROSS SECTION OF LEAF WITH POWDERY MILDEW



SPORE-BEARING STRUCTURES OF VARIOUS FUNGI, X1000

Disease organisms include certain fungi, bacteria, viruses, and nematodes. In order to control these disease organisms, you must know the organisms' life cycles and their behavior on crops. In every instance, knowledge of the culture of the crop and the diseases that affect it are essential for development of a practical, safe, hazard-free control program.

Holding plant diseases to acceptable levels for crop production or maintenance of ornamentals, landscape, and vegetation plants is a complex problem. Chemical pesticides play a large role in the control of many plant diseases. In most instances, chemicals should be used in conjunction with all other feasible methods of disease control.

Fungi as disease organisms

Most agricultural plants are susceptible to attack from many different fungi. For example, potato, bean, and cotton could be attacked by at least 30 different disease organisms. On a worldwide basis, fungi alone cause losses amounting to hundreds of millions of dollars a year. Any part of a plant's roots, stems, leaves, flowers, fruits, or seeds may be attacked. Fungi also attack harvested products, such as fruits, bulbs, rhizomes, and wood — in transit and in storage. The control of fungus disease organisms is greatly complicated by their diversity and variability. Some have spore stages specialized for spreading via air, in water, or in the soil; still others, because they produce resting seedlike spores, have survival periods of many years.

Some fungi have the capacity to penetrate healthy tissues directly, by means of a peg from the short germ tube of a spore. In other instances, the fungus is transported by a carrier, such as an insect, and then introduced into the plant. For example, the odor of the oak wilt fungus as it grows between the bark and the popwood attracts certain beetles that pick up spores that cling to their bodies; these spores are introduced into healthy trees on which the beetles feed. Some fungus organisms attack many plant species; others may be restricted to one. It is important in disease control to know which plants the disease organisms will attack.

Fungal attack produces a variety of plant symptoms. They may cause blights and rots on leaves, stems, fruits, and roots. When fungi invade roots, stems, and fruits abnormal growths or galls often result, such as club root of cabbage and stemgalls on conifers. Other symptoms are stunting from root infections and sudden wilting induced by fungi that plug the water-conducting tissues.

Many fungi move from plant to plant by spores. These spores vary in form and size. The red-spore stage of the wheat rust fungus moves many miles on air currents. Spores of other fungi may move only a few inches or feet by splashing rain. The spores of some fungi are exceptionally well adapted to survive under adverse growth conditions.

Spores of certain species of Fusarium, a root and wilt disease organism, remain alive in soil several years in the absence of a suitable host plant. Foliage-invading fungi, however, are typically shortlived and die when the infected foliage or stem tissues that sustain them rot away. Fungus spores are usually produced in tremendous numbers, and most of them do not find a host to attack. Spores suited to movement by water or by air currents are formed above ground. Water or high humidity is almost always essential for the active growth of fungi. Most spores will not germinate unless the relative humidity is 96 or 97 percent or higher, and many require wet leaf surfaces.

Bacteria

The number of major diseases caused by bacteria, in contrast to those caused by fungi, is relatively small. Nevertheless, certain bacterial diseases, such as fire blight of pear and apple trees, have been highly destructive and have resulted in much damage to these orchard crops. A major portion of the decay and spoilage of fresh fruits and vegetables in transit, storage, or markets is due to soft rot bacteria.

Species in all major families of the higher plants can be attacked by one or more kinds of bacteria. Certain soil-inhabiting bacteria, such as the crown gall and soft rot bacteria, affect a wide range of plant species. Only a few bacteria cause major diseases of forest or shade trees.

BACTERIAL WILT OF CUCUMBER

BACTERIA DEPOSITED WITH BEETLE FECES SPREAD THROUGH VESSELS OF LEAF, VINE AND TO OTHER VINES
VINES WILT AND DIE
BACTERIA OVERWINTER IN STRIPED AND SPOTTED CUCUMBER BEETLES WHICH HAVE FED ON INFECTED VINES

In most cases, the mechanisms by which bacteria cause disease are not well understood. Enzymes, as well as toxic materials, released from the bacteria readily come in contact with the plant tissue. Certain foliage-invading bacteria produce yellowing, and large yellow halos may surround small dead spots. In tobacco wildfire, for example, yellowing is caused by a bacterial toxin that interferes with the chemistry of the cell and indirectly affects chlorophyll (green pigment) production.

Since bacteria that induce plant disease are not sporeformers, they usually die when carried by the wind as isolated cells. Most foliage disease bacteria are therefore dependent mainly upon wind-driven rain for spread from plant to plant. Bacteria in vast numbers may ooze out of breaks in the plant tissue or through bark and leaf pores and be spattered or carried in rain droplets to nearby plants.

A grower may also spread bacteria during cultivating or harvesting operations, particularly if the foliage is wet. Bacterial wilt of alfalfa may be spread by harvesting equipment. Fire blight of pear and apple may be spread on pruning tools.

Insects can spread certain bacteria as well as make the wound through which infection occurs; wilt of cucumbers, pumpkins, and squash is carried by a cucumber beetle and Stewart's wilt of corn by a flea beetle. The bacteria may also survive the winter in the adult insects, and thus the severity of Stewart's wilt can

be predicted on the basis of the approximate numbers of corn flea beetles that have hibernated and survived the winter months. A wound need not be involved in the spread of some bacteria, such as fire blight, which may be carried by bees and introduced into blossoms.

Bacteria, particularly those that cause foliage diseases, usually survive in plant tissues, frequently within seeds. The ring rot bacterium remains alive in Irish potato tubers for months during storage. Then, when the tubers are cut into seed pieces at planting time, the bacteria is spread during cutting diseased tubers. In the fire blight of pear and apple, bacteria survive in the inner bark tissue near tree cankers.

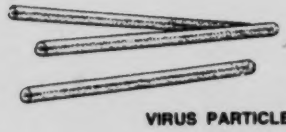
FIRE BLIGHT SHOWING SYMPTOM DEVELOPMENT FOLLOWING SPREAD OF BACTERIA FROM BLOSSOM TO LIMB

The major difference between fungi and most plant disease bacteria is the speed of infection. For most leaf fungi, fungus spore germination requires several hours. Foliage-invading bacteria are tiny enough to enter rapidly through natural openings or to be introduced into wounds such as those caused by insects or by cultivation and harvesting equipment. Such direct entry enables bacteria to escape the killing effects of chemical pesticides. Furthermore, many of the newer organic fungicides are not toxic to bacteria. Few bacteriacides have proven to be practical and effective in controlling bacteria without injuring crop plants.

Viruses

Viruses multiply only inside living cells and few living organisms are immune from viruses. Man, domesticated and wild animals, insects, higher plants, bacteria, and fungi can all be attacked. Practically all species of plants may also be attacked by one or more viruses.

Viruses cause many symptoms in plants. Sometimes they kill the plant. More often they cause lesser damage, which results in reduced yields and poor quality products. Most virus diseases fall into two clearly defined groups: the mosaics, which cause mottling and spotting of leaves; and the yellows, which chiefly cause yellowing, leaf curling, dwarfing, or excessive branching but little or no mottling or spotting.



VIRUS PARTICLES, X 26,000

Viruses can be spread in a number of different ways. Many of the mosaic-type viruses can be transmitted mechanically by rubbing juice extracts from diseased plants onto the surfaces of leaves of healthy plants.

All viruses that spread through the plant system can be transmitted by grafting. Vegetative propagation of plants, such as fruit trees, result in the spread of many viruses. Most viruses invade all parts of the host plant; therefore, when buds, scions, or other vegetative parts of diseased plants are used for propagation, the new plants are usually also infected. Tree fruits, strawberries, potatoes, sweetpotatoes, and other crop plants that are regularly vegetatively propagated are likely to carry

several viruses that have accumulated in the p...ing stock over the years.

APHID TRANSMITS VIRUS OF BARLEY YELLOW DWARF

Insect carriers spread many plant viruses. Depending on the virus, carriers may be leafhoppers, aphids, whiteflies, thrips, beetles, or other chewing insects. After certain viruses are picked up by the insect carrier through feeding on diseased plants, they may persist in the insect and sometimes even reproduce themselves, whereas in other instances the insect is able to transmit the virus for only a short time. A few viruses are transmitted by mites. Some soil-borne viruses are spread by nematodes, while others are spread by certain fungi.

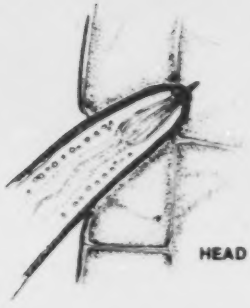
After a plant becomes infected with a virus, there is usually no economically feasible way to cure it. Methods of control, therefore, center on preventing spread of the virus, or by developing varieties immune or resistant to the virus disease.

If the virus is seed borne, the use of virus-free seed is often an effective control measure and is commercially practiced against lettuce mosaic and the common bean mosaic. Virus diseases of potato have been successfully controlled for many years by selecting virus-free planting stocks.

In some instances, when the spread of a virus is slow, the use of virus-free planting stock for establishing the planting — an approach used to control many virus diseases of tree fruits, grapes, strawberries, and raspberries — is very effective.

Reducing the population of insect carriers with insecticides has given at least partial control of some virus diseases.

In many cases, disease resistance has been effective in controlling virus disease. For example, resistance to curly-top virus in sugar beets has made the culture of sugar beets possible in areas where the disease formerly threatened to eliminate the industry.



HEAD OF NEMATODE WITH SPEAR

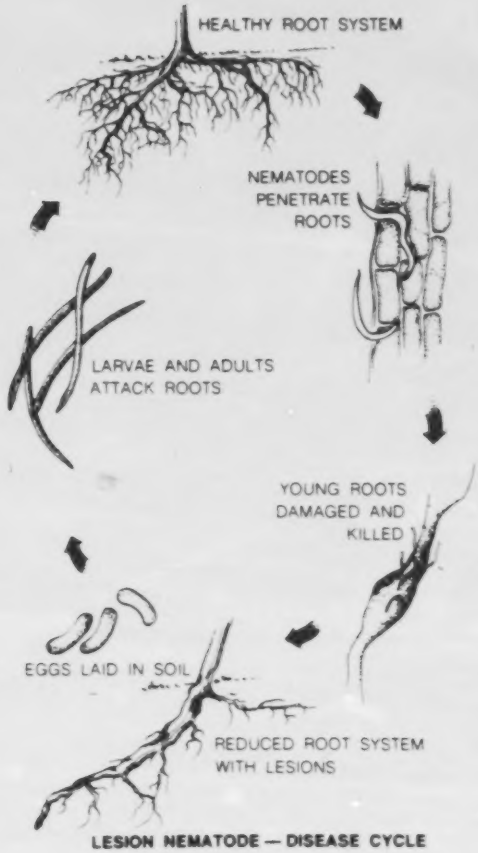
Mycoplasma-like organisms

In addition to viruses, a group of plant diseases formerly thought to be virus-induced have been recently attributed to infection by mycoplasma-like organisms. In general these organisms are extremely small, almost the size of viruses and are not visible with an ordinary microscope. They induce yellowing symptoms in many plants. Probably the most commonly known problem is Aster yellows, a disease present almost everywhere asters are grown outdoors. In contrast to the viruses, the mycoplasma diseases often may be treated by antibiotic therapy much the same as the mycoplasma diseases of animals. As time passes, undoubtedly much more will be heard from and known about this problem.

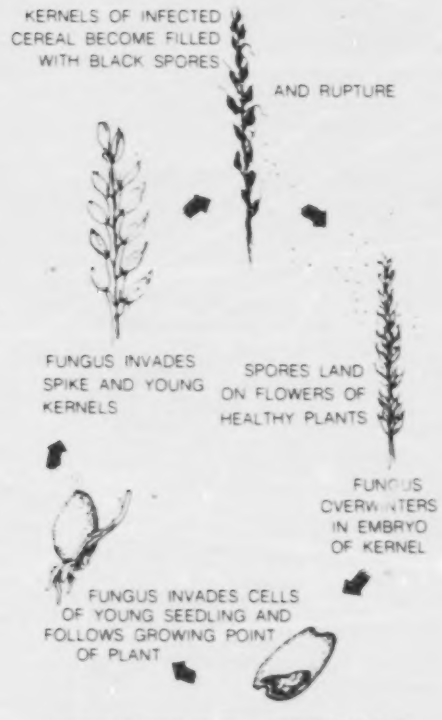
ROOT GALLS PRODUCED BY ROOT-KNOT NEMATODES

Nematodes

More than 9,000 species of nematodes have been described, yet


HEALTHY ROOT SYSTEM
NEMATODES PENETRATE ROOTS
LARVAE AND ADULTS ATTACK ROOTS
YOUNG ROOTS DAMAGED AND KILLED
EGGS LAID IN SOIL
REDUCED ROOT SYSTEM WITH LESIONS

LESION NEMATODE — DISEASE CYCLE


KERNELS OF INFECTED CEREAL BECOME FILLED WITH BLACK SPORES AND RUPTURE
FUNGUS INVADES SPIKE AND YOUNG KERNELS
SPORES LAND ON FLOWERS OF HEALTHY PLANTS
FUNGUS OVERWINTERS IN EMBRYO OF KERNEL
FUNGUS INVADES CELLS OF YOUNG SEEDLING AND FOLLOWS GROWING POINT OF PLANT

WHEAT LOOSE SMUT — DISEASE CYCLE

the unknown species still probably outnumber the known. Nematodes are distributed throughout the world in a wide variety of environments. They include animal and human parasites, plant parasites, and free-living forms.

The symptoms of nematode damage to plants are not distinctive. Since the most common and important damage occurs to roots, the above-ground symptoms often closely resemble those of any other poorly functioning root system. Thus, it is rarely possible to recognize a nematode problem without root examination and soil nematode analysis.

Nematodes are small, eel-shaped, unsegmented worms which move with a snake-like motion in water. The mouthparts of all nematodes parasitic to crop plants include a spear — a needlelike apparatus capable of puncturing plant cells. Spears of most plant parasites are hollow, and saliva is injected through them into plant cells. Cell contents, partially dissolved by saliva, are then ingested by the nematodes.

Plant-parasitic nematodes may be divided into two groups, internal and external feeders. The internal nematodes enter and feed inside plant tissue; the external remain outside and feed on surface cells. Nematodes from both groups occur on both above-and below-ground plant parts.

Root feeding destroys roots as well as impairs the uptake of water and minerals in the remaining diseased roots. Root-knot nematodes, which are worldwide in distribution, cause some of the most important plant diseases, particularly in warmer climates and in greenhouses. Salivary excretions from the feeding of these internal nematodes cause the formation of large cells that in turn result in swollen, distorted, and knotty roots.

The internal-lesion nematodes move throughout the outer portion of the host root, feeding periodically and laying eggs. This movement and periodic feeding results in the death of scattered root cells, and often in the destruction of nonwoody roots.

The external feeders feed from the surface of the root by inserting long spears into the outer cells. In general, their complete life cycle takes place at or near the root surface. Nematodes are known to transmit several soil-borne viruses.

Understanding disease spread

Plant diseases caused by microorganisms are contagious. In order for diseases to spread, sources of these organisms must reach healthy plants and establish new infections. These sources are called inoculum. Inoculum is any material that is potentially capable of producing infection. It may consist of virus particles, bacterial cells, fungus spores, fungus threads, nematodes, etc.

In the typical spread of a plant disease, inoculum is produced in or on the infected plant by the disease organism. This inoculum

is then released and can come in contact with a susceptible plant. Usually, a large proportion of the inoculum dies. Only a very small fraction of the total inoculum reaches a susceptible plant and only a fraction of this succeeds in infecting the plant and causing disease. A single kernel of smutted wheat contains from 2- to 12-million spores of the smut fungus. A single gall to the cedar-apple rust may produce millions of spores.

Each disease organism has a characteristic rate of reproduction. In some, the inoculum is produced only once for a short period during the season. Other diseases, such as apple scab and late blight of potatoes, produce new sources of inoculum many times during the season.

Sources of inoculum

Inoculum may originate from a few or many diseased plants; it may be produced inside the plant, at the plant surface, on plant refuse, or on organic matter in soil, depending upon the nature of the disease organism. Viruses and bacteria multiply within their hosts. However, many fungus organisms characteristically reproduce from infection centers on the plant's surface. In addition, many diseases live and reproduce in soil, on weeds, or on other plants of lesser value than the crop in question. Inoculum may be found in such locations for a long time and be a reservoir of inoculum that is a threat to a crop.

Wild chokecherry that grows adjacent to orchards may be a reservoir of the X-disease virus of peach in the Northern United States. Removing the chokecherry controls the disease.

INFECTION SPREAD BY WINDBORNE SPORES PRODUCED USUALLY ON LOWER SURFACE OF LEAVES
BLIGHT OF LEAVES AND STEMS
MOVEMENT OF SPORES IN WATER TO LEAVES AND PRODUCTION OF BLIGHT SPOTS
BLIGHT OF TUBERS
SPORES PRODUCED ON STEMS FROM TUBERS

LATE BLIGHT OF POTATO — DISEASE CYCLE

Chemical control of weeds that serve as hosts for viruses sometimes controls the spread of viruses to crops.

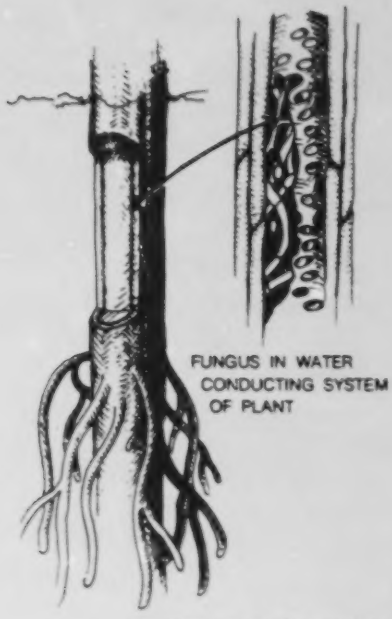
With soil-borne disease, the transfer of inoculum within soil occurs slowly and over short distances; however, with flowing water transfer may be rapid and occur over considerable distances. Irrigation and flood water can spread inoculum. Man can also spread soil-borne inoculum by moving soil on farm machinery from one field to another or nursery stock from one location to another.

Inoculum can travel rapidly through the atmosphere. Air-borne spores can spread through a field in a few days. For example, late-blight inoculum can be spread rapidly through potato fields and from field to field throughout a potato-growing area.

Each type of disease organism is adapted to dispersal in a characteristic way. Principal ways that inoculum spread are by air, water, plant debris, insects, animals, and man.

General approaches to plant disease control

Control of plant disease is the prevention or reduction of disease. You can sometimes control a disease by using a single procedure, but satisfactory control of most diseases requires



FUSARIUM WILT OF TOMATO

multiple control methods. A well conceived control program should consider the characteristics of the disease organism and the crop, the cultural and climatic conditions under which the crop is grown, and a knowledge of available disease control procedures.

Avoidance of sources of disease organisms

Choice of planting site

The choice of a suitable planting site is important in order to avoid fields infested with root-infecting organisms, such as those causing Verticillium and Fusarium wilt, or to avoid fields containing crop residues that can serve as a source of inoculum for air-borne spread.

Choice of planting date

Choose planting dates to provide good environmental conditions (temperature and moisture conditions) that are more favorable for growth and development of the crop plant than of the disease organism.

Use of disease-free planting stock

Disease-free planting stock, grown in a disease-free area or in a certification program, provides one of the most effective means of plant disease control for seed, tuber, or plant-borne disease organisms.

Exclusion of the disease source

Disease organisms may be excluded from a crop production area by treating plant materials, by inspection and quarantine, and in some cases by eliminating carrier insects.

Treatment of plant materials

Seeds, tubers, corms, and other propagative parts of plants can be treated by heat, gases, or chemicals, to destroy disease organisms and thus prevent both direct injury to plant parts and introduction of disease organisms into a new location.

Inspection and certification

Inspection of plant propagation material, followed by certification that they are free of disease when marketed, instills confidence in intrastate and interstate shipments.

Exclusion or restriction by plant quarantine

The purpose of plant quarantines is to prevent the spread of disease organisms from areas where they are present, to areas where they do not occur. A quarantine is justified only if there is little chance of an organism being spread naturally from one area to another. In practice, plant quarantines are often not very effective, because they usually are not established soon enough or because of the biological or physical limitations in implementing them.

Elimination of insect carriers

Many plant disease organisms are carried by insects. If the insect carrier can be effectively reduced, the chances of them

DUTCH ELM DISEASE — DISEASE CYCLE

LATE SPRING
SPORES PRODUCED ON BARBERRY LEAF INFECT WHEAT
OVERWINTER ON BARBERRY
SPORES PRODUCED ON STEM OF WHEAT INFECT BARBERRY
DURING GROWING SEASON
LATE SUMMER

BLACK STEM RUST OF WHEAT — DISEASE CYCLE

spreading the disease to healthy plants are also reduced.

Eradication of the disease source through cultural or chemical sanitation

Complete eradication is practically impossible to accomplish. However, susceptible crop plants and nonsusceptible crops often may be rotated in a way that eliminates the population of the disease organism in a field site. Crop rotation is only partially effective against soil-inhabiting organisms that are capable of surviving in the soil for several years.

Removal and destruction of diseased parts or entire plants can prevent the spread of disease in an established commercial planting, and it is also an effective procedure in the production of disease-free planting stock. The purpose of plant removal is to destroy a source from which a disease organism might spread to healthy plants in the same or other plantings.

Eradicating the alternate hosts of certain rust disease organisms has long been used to break their life cycle.

> The eradication of gooseberry plants within about a quarter of a mile of white pines has been effective in controlling white pine blister rust in many areas. The eradication of barberry plants has reduced the chance of development of new outbreaks of black stem rust of wheat in the Eastern U.S.

Disease organisms can be destroyed in stored plant parts by heat, fumigation, and other chemical applications. Treatment to reduce or inactivate disease organisms in the soil may also be used. Soil may be treated with chemicals, heat, or by flooding or fallowing.

Most fumigant-chemical treatments reduce or eliminate all organisms in the soil — good as well as harmful. Treatments such as these should be used only in the absence of crop plants. Because disease organisms must be largely eliminated from the crop's root zone, a large amount of soil must be treated. Compared with insect and weed control pesticides, a massive quantity of chemical is required.

Heat treatment of soil is highly satisfactory to use with small quantities of soil in greenhouse benches, mushroom houses, and beds or in limited ground-bed operations. Field-burning may also be used satisfactorily to eliminate disease sources in plant parts on or near the soil's surface, such as with the blind seed disease of ryegrass or plantings for seed production. However, burning is also considered a source of air pollution.

Plant protection

Plants may be protected from disease organisms by chemical applications or through adjustments in cultural practices.

Most spraying, dusting, and seed treatments put a toxic chemical barrier between the plant and the inoculum in order to

RESISTANT VARIETIES MAY BE DEVELOPED

prevent infection. In this sense, chemicals are protectants.

Improving air circulation in greenhouses to reduce humidity at the leaf surface is an example of modifying the environment in order to protect the plant from infection.

To prevent storage diseases, favorable enrivonmental conditions must be maintained to ensure normal wound-healing of the product being stored (e.g., fruits and vegetables), but conditions must not favor rapid development of disease organisms.

Humidity should be high enough to prevent excessive drying and to facilitate wound-healing but low enough to avoid heavy fungus growth. Storage of each crop must be considered as a separate problem, and the environmental conditions required for curing and the maintenance of quality must be weighted against the environmental conditions that favor disease.

Development of resistant crops

Resistant varieties may be selected or developed by proper selection, breeding for resistance, or obtaining resistance through plant nutrition.

Physiological resistance is usually based on an inhibitory substance in the tissues of the crop plant or on some form of chemical incompatibility of crop disease organism. Mechanical resistance may include an unusually thick cuticle or cork layer or other physical characteristics that make it difficult for organisms to come into direct contact with or penetrate the plant tissues. Functional resistance includes such reactions as the closing of leaf pores when conditions are favorable for infection.

Acquired immunity comparable to that induced in humans and animals by vaccination or inoculation with serum has not yet been used successfully with plants.

Control through the use of chemicals

One of the most effective means of plant disease control is the use of natural or synthetic chemicals. Chemical control is often the only feasible means of attacking a disease problem. It is often more economical and effective than other measures. Many diseases cannot be controlled by any other means, and adequate quality and yield of crops require disease control through the use of chemicals.

Chemicals may act either to keep out the disease organism (exclusion by seed treatment); to remove, or eliminate the disease organism at the source (eradication); to prevent plant infection (protection); or to cure plants (therapy). The majority of chemical control measures involve the principle of protection — preventing the disease organism from entering the plant and starting an infection. To accomplish this, chemicals may be used to inactivate the organism at the site of infection.

FUNGUS GROWS ON LEAF SURFACE AND FORMS SCABS WHICH RELEASE SPORES TO INFECT NEW LEAVES AND FRUIT
INFECTED LEAVES FALL TO GROUND
SPORES WINDBORNE IN SPRING TO YOUNG APPLE LEAVES
SPORES OVERWINTER IN DEAD LEAVES

APPLE SCAB — DISEASE CYCLE

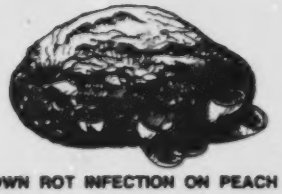
In addition to the use of fungicides, chemical control of disease may be achieved with nematicides, insecticides, herbicides, or bacteriacides. In addition to providing direct control of pathogenic nematodes, nematicides may control nematode carriers of disease organisms or kill nematodes that provide infection sites for fungi and bacteria. Insecticides similarly control insect carriers of disease organisms, such as the leafhoppers and aphids that transmit viruses.

Herbicides may be used to prevent the production of disease organisms by eliminating the alternate host of the organism. For example, herbicides are used to kill currants and gooseberries that are alternate hosts for the white pine blister rust fungus. Herbicides may also be used to kill weeds that may serve as alternative hosts. Certain virus diseases are particularly amenable to this means of control.

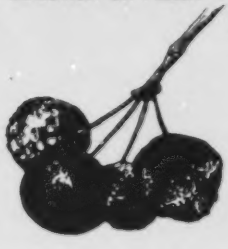
Many chemicals are toxic to various life forms. This is an essential feature of chemical control. Chemicals must be less toxic to the crop plant than they are to the organism they are designed to control. A protective fungicide should kill fungi without significant damage to the crop plant.

Chemical treatment of plants may be used to prevent the reproduction of disease organisms. Treatment of apple leaves protects leaves from new scab infections and prevents spore production in existing infection centers on the leaves.

Herbicides can chemically prevent the production of inoculum. This treatment is feasible when one series of plants is of little or no value relative to the crop plant. The destruction of barberry as a source of stem rust of wheat is an example; however, this destruction is only partially effective as a control measure. Spores, produced on wheat, are wind-borne at high altitudes and may be deposited hundreds of miles from where they were produced. The same principle of destroying a plant of low value applies to other organisms with alternate hosts.



BROWN ROT INFECTION ON PEACH



BROWN ROT INFECTION ON CHERRY

Chemically destroying gooseberries and currants prevents spore formation that spreads the white pine blister rust from these hosts to the white pine.

An example of inactivation of a potential inoculum source is the destruction of cull potatoes that may harbor the late-blight fungus, or herbicide spraying cull piles to prevent sprouting and subsequent disease development. Here the source of the fungus is available, evident, and small. By contrast, prevention of early season spore formation and release by the apple scab fungus by treating the orchard floor with fungicides is relatively ineffective and not widely practiced. Not only is the source widespread and abundant, but also only the spores in the upper layer of leaves are exposed to the fungicides, and all of the sources are not evident. Again, it is the amount of inoculum that survives that is important.

Many plant parts (e.g., seeds, bulbs, tubers, fruits, and stolons)

carry organisms that can cause storage rots and many other types of disease. These diseases can be controlled if the source can be eliminated or reduced to levels insufficient to cause disease. Treatment with chemicals, gaseous fumigation of plant materials, and storage space, along with adjustment of environmental factors may be used to eradicate or exclude disease sources.

The principle of seed treatment is primarily control of sources of disease, although chemical seed treatment may also protect against infection from organisms in the soil. Fungicides are used as seed protectants to coat the seed and provide protection against damping-off and seed-rotting organisms in the soil.

To be effective in providing protection of susceptible foliage, fungicides and bactericides must be on the plant before the organisms arrive. Fungicides may prevent spore germination, cause abnormal germination so that infection fails, or delay the germination process sufficiently so that drops of water on leaf surfaces dry before the germ tubes of germinating spores penetrate the plant. The time required for the organism to enter the host may be short, sometimes only an hour or two.

To prevent penetration and infection, an effective dosage of a fungicide must be applied. In contrast to insects, which move over the plant before they feed or during feeding, units of fungus inoculum do not migrate freely after they are deposited, even when spores are motile. Fungicidal deposits that are evenly distributed over the host surface are more effective than unevenly distributed deposits.

Protection of foliage by fungicides is usually made only by repeated applications. Sprays that control late blight of potato must be applied every few days during the major infection periods.

In-row or spot applications of soil fungicides at planting time may protect the young seedling from many types of soil organisms. In this case, the chemical inactivates the inoculum and prevents it from invading susceptible young crop plants.

Soil fungicides may also be used to protect the roots of established plants from invasion by disease organisms. These materials, applied as drenches, must penetrate the root zone in an effective concentration in order to inhibit fungi or nematodes.

CHEMOTHERAPY WITH SYSTEMIC FUNGICIDES

Chemotherapy with systemic fungicides

Chemotherapy is the control of disease through the use of chemicals that exert their action within the plant. Such chemicals and techniques cure or treat new or established infections.

These chemicals may act by inactivating toxins produced by the disease organism; or by a direct fungitoxic or fungistatic effect on the disease organism. Indirect approaches to

chemotherapy involve chemically increasing the resistance of the plant or otherwise changing the chemistry of the plant so that it is no longer a suitable target.

Lesson 4

PLANT DISEASE CONTROL

Answer the following questions True (T) or False (F).

____ 1) Most kinds of crops are susceptible to attack by many different disease organisms.

____ 2) Fungus disease organisms never move from plant to plant.

____ 3) Certain foliage-invading bacteria produce yellowing symptoms.

____ 4) Virus infected plants are easily cured with protectant fungicide treatment.

____ 5) Symptoms of nematode damage to plants are distinctive and easily recognized.

____ 6) Certain plant diseases may be spread by insects.

____ 7) Most plant diseases are easily controlled by complete eradication of the casual organism.

____ 8) Chemical pesticides are always needed for plant disease control.

____ 9) Chemical seed treatment never protects the seed from infection.

____10) Systemic fungicides may control diseases within the plant.

Circle correct answer:

11) Fungus disease organisms induce:
   A) A wide variety of plant symptoms
   B) The same symptom on most crops
   C) Rotting of all attacked plants
   D) Slow wilting
   E) Rapid growth

12) Bacterial diseases are easily controlled by:
   A) Fungicide sprays
   B) A wide range of bacteriacides
   C) Cultivation
   D) Pruning
   E) Are very difficult to control

13) Nematode feeding on plant roots:
   A) Always results in lumps on root knots
   B) Always results in roots seeking water at a greater depth
   C) Usually results in impaired ability of the plant to take up water and nutrients
   D) Is easily diagnosed
   E) None of these

14) Air-borne spores can spread a disease organism throughout a field in:
   A) A few seconds
   B) A few days
   C) A few years
   D) A few hours
   E) None of these

15) In some instances, plants may be protected from disease organisms by:
   A) Chemical applications
   B) Adjustments in cultural practices
   C) Biological control
   D) Mechanical controls
   E) All of these

Answers
1 T
2 F
3 T
4 F
5 F
6 T
7 F
8 F
9 F
10 T
11 A
12 E
13 C
14 B
15 E

Lesson 5
VERTEBRATE PEST MANAGEMENT

ALL SHARE A COMMON CHARACTERISTIC

Fishes, amphibians (frogs, toads, salamanders), reptiles (snakes, lizards, turtles), birds, and mammals are classified as vertebrates. All share with man a common characteristic—a backbone. Fishes, amphibians, and reptiles are cold-blooded; their body temperature approximates their surrounding environment. Birds and mammals are warm-blooded with relatively stable body temperatures independent of their environment. All vertebrate forms have evolved uniquely adapted to many habitats.

Warm-blooded vertebrates represent a high order of living things. They occupy a dominant role in natural ecosystems, and they are closely allied with man in an ecological sense. Wildlife depends on food and shelter as does man. The same environment furnishes these necessities to both man and wildlife. Therefore, wildlife is of considerable interest, value, and concern to man.

Wild vertebrates are often referred to as "wildlife." Wildlife species are important to man because of their economic, social, recreational, and ecological values. However, in varying times and places, these values may change.

Historically, the colonists valued most wildlife as sources of food and clothing. However, in early days bounties were paid for squirrels because of their destruction of crops. Today squirrels are protected as game species. Colonists bountied wolves from the beginning, but today wolves are classified as an endangered species and are now protected.

Control of wildlife damage is one of the most complex and controversial aspects of wildlife management. Some species, in certain circumstances, may cause significant damage to surrounding natural resources, including other wild species, or to forest and agricultural crops or livestock, or may endanger public health or safety. Although such damage is often due to an excess population of the species, it also may result from other less apparent reasons. Problems of ecological competition, or the struggle of a species to survive in a changing environment, are important to evaluate.

Whenever man's activities encroach on the natural environments of wild species, the potential for conflict is created. Whether it be a corn field adjacent to the forest with resulting deer damage, crops planted on bottomland adjacent to a marsh roost of red-winged blackbirds, or a cabin built in prime forest habitat of the white-footed mouse, the ecological consequences are often predictable and the conflict should be evaluated on this basis.

Control of wildlife damage is further complicated by differing social views of the problem. A growing number of people see the positive values of most wild species and some question the need for control programs. Persons who experience economic and ecological damages are quick to recognize the desirability of preventing them. When anyone considers wildlife damage

control, he must recognize these different points of view.

BLACK BEAR

Principles of vertebrate pest-damage control

The essential principles of vertebrate pest management are:

1) Wildlife may have both positive and negative social and economic values. Certain species may damage human interests, other wildlife, or their habitats, necessitating prevention or control of such damage as part of wildlife management.

2) Techniques known to be of value in counteracting damage situations include: a) exclusion or mechanical protection; b) use of repellent chemicals or devices; c) environmental or biological control; and d) reduction of the offending population by transfer or by lethal methods.

3) Lethal-control methods must be socially and economically acceptable and should be the minimum necessary to bring damage within tolerable limits.

4) Control methods must be efficient, safe, economical, humane, and as selective as possible; they must conform to local, state, and federal laws and regulations.

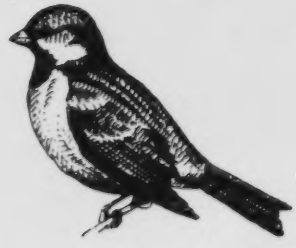
5) Control programs must not be conducted if they would be hazardous to any endangered species of wildlife.

RED-WINGED BLACKBIRD

Legal considerations

Wildlife occupies a unique position as a natural renewable resource. It is public property held in trust for all people by state and federal governments. The federal Migratory Bird Treaty Act protects migratory birds; the Bald Eagle Act protects eagles; marine mammals are protected by the Marine Mammal Act; and endangered wildlife by the Endangered Species Protection Act. The Lacy Act prohibits the movement between states of wildlife taken in violation of state laws.

State wildlife agencies, rather than federal agencies, have the primary responsibility and authority for the protection and management of most wildlife. In Pennsylvania, the Fish Commission and Game Commission are the responsible wildlife management and regulatory agencies. Complex legal codes, known as the Fish Law and the Game Law, define and guide wildlife management procedures. All states have designated wildlife agencies but the details of wildlife management laws vary.



ENGLISH SPARROW

The Migratory Bird Treaty Act offers protection to all migratory birds except English (house) sparrows and European starlings. The regulation:

> . . . permits authorizing the killing of protected birds that are committing serious depredations on crops, property, or other interests when the injury is substantial and can be abated only by killing some or all of the offending birds. In addition, all species of blackbirds, cowbirds, and grackles may be killed without permit

when such birds are committing or about to commit depredations on shade or ornamental trees or agricultural crops (Code of Federal Regulations, Title 50, parts 11 and 16).

This regulation clearly limits the species which can be controlled by lethal methods.

State laws further define and regulate the harvest of game fishes, game birds, game mammals, furbearers, and other categories of wildlife. Species such as the Norway rat, house mouse and others have no legal protection; however, lethal control programs directed at them must conform to pesticide use restrictions.

Wildlife species, except in very few instances, are legally protected, and it appears that as public attitudes continue to change, more vertebrates may be added to the protected list. There are more species of protected birds than mammals, partially because there are more species of birds than mammals, and because apparently people hold birds, rather than mammals, in higher esteem. Species such as rats, snakes, and bats have few defenders, while the lowliest of birds is usually sympathetically regarded.

GREAT HORNED OWL

From these observations, it may be inferred that pest control of birds is likely to be more complicated than control involving reptiles or certain mammals. This is reflected in the legal restraints governing vertebrate pest control. Species not directly protected by laws may be protected by restrictions governing the materials and/or methods which may be used to control them. English sparrows and European starlings are legally unprotected, yet they may not be indiscriminately killed because of pesticide-use restrictions and other restraints such as limitations on shooting and trapping.

Some state laws specify control methods and procedures individuals can use when confronted by damages from wildlife. Few wildlife species defined as game may be controlled with poisons. When trapping and/or killing is permitted, there may be certain procedures that must be followed, such as contacting and reporting to local game protectors or wildlife agency staffs.

When choosing wildlife depredation control methods, be aware of local ordinances or regulations. For example, discharging firearms in urban areas may be prohibited by local ordinance. The use of scare devices based on noise may conflict with ordinances prohibiting unreasonable noise and/or disturbing the peace.

Few pesticides are registered for use on vertebrates. Registered vertebrate pesticides have labels which name the offending or target species, the details of application, and precautions to be taken. Toxicants or repellents may not be used on species other than those listed on the label. To do so would be equivalent to the use of an unregistered pesticide.

RACCOON

Diagnosis of problem and need for control

One of the primary considerations in vertebrate pest control is determining the need for control. Individuals may differ in their attitudes toward vertebrate pests; some people are willing to accept animal damage which would be considered intolerable to others. However, if wildlife pests were endangering human health and safety or destroying agricultural crops or facilities, control would be justified.

The advisability of vertebrate control efforts would not be questioned if it could be demonstrated that a pest or pests were endangering human health through the threat of disease, or that human safety was being threatened by concentrations of birds at airports where aircraft-bird collisions have resulted in loss of human lives.

Protection of agricultural crops is justifiable, and in some circumstances, pest control is probably warranted. This is an area where opinion varies. One person may be willing to accept an amount of crop damage which would be completely unacceptable to another person. It is generally agreed that many farmers, for example, support wildlife in numbers on their farms; in so doing, farmers are willing to accept some damage to their crops by wildlife. The extent of depredations acceptable to growers depends on the species causing the problem and on the grower's individual philosophy. It would be unlikely that any grower would accept mice in his orchard or rats in his corn crib. On the other hand, a grower might accept depredations from wild turkeys because this bird is generally valued by most people.

WILD TURKEY

Protection of man's structures, tools, and equipment may be justified when vertebrate depredations threaten the usefulness of these facilities. Bird droppings on surfaces susceptible to deterioration, or rats gnawing holes in buildings are examples of this kind of damage.

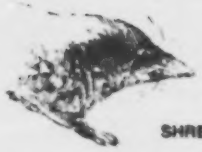
In any disputes over the justification for vertebrate pest control, regulatory agencies will make the determination. The complainant should be able to demonstrate damage before undertaking pest control, especially when protected species are involved.

WHITE-FOOTED MOUSE

When robins damage ripening fruit, a federal permit would be required to kill the offending birds. However, the use of protective netting to exclude the birds does not involve a lethal method and no permit would be needed.

A factor which frequently causes confusion in vertebrate pest control is the proper identification of the problem-causing pest. If the pest is misidentified or misnamed, it complicates control programs because the choice of material or method to be used depends upon correct identification. One method or material which might be effective against one pest might be illegal or ineffective when used against another pest. Meadow mice are frequently misidentified as moles, yet different control tech-

MEADOW MOUSE



SHREW

MOLE

niques must be used on each of these pests.

Occasionally identification may be made by observing the pest "in the act"; however, frequently identification must be made from signs left behind by the pest.

Knowing the vertebrate species in the area and their habits helps in identifying pest damage. Often the process of identification is one of elimination. Time of year; nature and extent of damage; size of involved species as indicated by tracks, teeth marks, and droppings; and location of damage may need to be considered before proper identification is made. Once the species has been identified, it should be correctly named. Generally accepted popular names are adequate, but avoid using colloquial names because they often lead to confusion. Most legal control restrictions are based on accepted common names although scientific names are usually added so that there is no confusion in identifying the regulated species. Since restrictions on vertebrate pest control are highly specific, identification of the pest must be accurate.

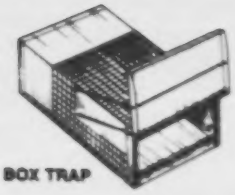
In most vertebrate pest control activities, there are several choices of materials and/or methods for combating the problem. Choose the program which uses only properly registered and legal methods or materials, and use the methods or materials prescribed on the label. Using registered materials in any other ways than those specified is as unacceptable as the use of unregistered materials.

Once the pest species has been properly identified and control is justified, a choice of method and/or material must be made. Many times damage may be controlled within tolerable limits by nonlethal materials or methods; except for few species, a program designed to limit damage without sacrificing the offending species is preferred over a program involving lethal means.

Alternative means of damage prevention by pests include making the crop or facility inaccessible, moving the pest unharmed to an environment where it will not be a problem, using a repellent which makes the susceptible crop or facility undesirable, altering the environment to make it unattractive to the pest, and presenting the pest with alternative commodities or facilities. Consider these alternatives before you choose a program involving lethal means. Even when lethal type controls appear to be the only answer, there usually is another choice which may be less likely to present hazards to the environment or to species other than the pest itself. However, in most instances legal restraints dictate limited choices.

Environmental methods

Damage from vertebrates can often be solved by these environmental methods: relocating susceptible crops away from a forest edge where a concentration of deer are likely to feed on the crop; using resistant varieties of crops, such as corn with



BOX TRAP

tough, heavy husks to reduce blackbird damage; and practicing care and sanitation with stored grains and feeds to reduce the attractiveness of these areas to birds and mammals.

Mechanical methods

Wild animals can be stopped from causing damage by using wire guards around fruit and ornamental trees and shrubs to prevent rodent gnawing, setting mechanical traps to capture the offending species, or covering ripening fruits with netting to exclude birds. These methods are alternatives to chemical toxicants.

WOODCHUCK

Chemical methods

Chemical repellents may make treated areas unacceptable by odor or taste and thus deter damage. In this way, the offending animals may be forced to find a different location or new food source. A repellent applied to shrubbery may protect it from rabbits and force the animals to seek an alternate food source. Toxic chemicals can sometimes reduce the numbers of an offending species. Toxicants have been effective in reducing orchard mice populations.

The number of restricted-use pesticides permissible to use in vertebrate pest control programs is few, and there is no guarantee that the number will increase in the near future. It is possible that present and future research efforts may result in the discovery of new chemicals for vertebrate pest control. Ideally, a control chemical should affect only the species over which control is intended, and not other species or the environment. While certain pest-control chemicals now in use are more toxic to some species than to others, very few materials are toxic only to the intended species.

Careful use of chemicals minimizes the hazard to nontarget species.

Factors to consider are:
1) The bait on which a toxicant is used.
2) The time of year the control effort is undertaken.
3) The method of chemical placement.
4) Area of placement.

It is possible to use a broad-spectrum pesticide (pesticides having effect on several species) selectively; however, knowledge of the chemical, the area's vertebrate species, and their habits is important. The program must also be carefully supervised. Pigeons may be controlled during the winter months in the northern parts of the country when most beneficial birds have migrated south. By exposing pigeon bait on the tops of flat roofs, few other bird species are likely to find the bait. Toxicants for pigeon control may be used on bait particles too large to be eaten by most other birds. By taking these precautions, it is possible to selectively use a chemical that is toxic to many

SHORT-TAIL SHREW

species. Placing orchard mouse baits in holes, covered runways, or under protective cover is another example of selective vertebrate pest control. Labor costs are increased when these special efforts are taken; however, unless and until selective materials are developed, existing ones must be carefully used to guard against large-scale accidental kills of beneficial species. If society continues to permit the use of existing materials, it must be willing to absorb the added costs of careful pest control methods to protect the environment and beneficial species.

Reproductive inhibitors that control vertebrate populations show considerable promise with some species. Research is continuing and the future may see birth control for pest species as an acceptable means of combatting pest problems. In many species the annual turnover of populations is great. This means that the number of births must at least equal the number of deaths annually if the species is to continue to exist at present numbers or to increase. If it were possible to prevent this recruitment even over a single generation, the pest species numbers would be significantly reduced; theoretically the numbers of a pest species could be held at tolerable levels, once a tolerable level was determined. Problems in the field use of reproductive inhibitors must be overcome before the method can be widely used.

Sources of assistance

Vertebrate pest damage control often requires help from one or more public agencies whose responsibilities include wildlife protective regulations. Information on identification of depredating species, legal status, permits, and other assistance can be provided by contacting the U.S. Fish and Wildlife Service, Washington, D. C. 20240 and your state fish and wildlife agency.

Lesson 5

VERTEBRATE PEST MANAGEMENT

Answer the following questions True (T) or False (F).

____ 1) The pest that is causing damage must be accurately identified before control methods are used.

____ 2) Toxicants may be freely used to control problem game species.

____ 3) Any amount of crop loss caused by wildlife is sufficient reason for a control program.

____ 4) Any pesticide which will do the job is alright to use.

____ 5) Migratory birds are unprotected.

____ 6) The use of toxicants is always necessary to solve wildlife damage problems.

____ 7) State laws, in addition to the pesticide label regulations, may specify wildlife damage-control methods.

____ 8) Beneficial wildlife species can be pests under some circumstances.

____ 9) Most pest-control toxicants are poisonous only to the species being controlled.

____10) Usually there are several methods to prevent damage by a wildlife species.

Circle correct answer:

11) One of the following is not a vertebrate animal:
   A) Brook trout
   B) Red-winged blackbird
   C) Gray squirrel
   D) Rattlesnake
   E) House fly

12) One of the following is not protected:
   A) Robin
   B) Catbird
   C) European starling
   D) Bluebird
   E) Baltimore oriole

13) In any case of animal damage you should first:
   A) Call your fire department
   B) Get your shotgun
   C) Find out what animal is doing the damage
   D) Set a trap
   E) Use a poison

14) One of the following would have little effect on the selectivity of an animal damage control program:
   A) The kind of bait used
   B) The time of year the bait is used
   C) The exact placement of the bait
   D) The general area baited
   E) The day of the week on which the bait is exposed

15) A single feature identifies all vertebrates:
   A) They lay eggs.
   B) They have feathers
   C) They are warm blooded
   D) They have backbones
   E) They live on land

Answers
1 T
2 F
3 F
4 F
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10 T
11 E
12 C
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14 E
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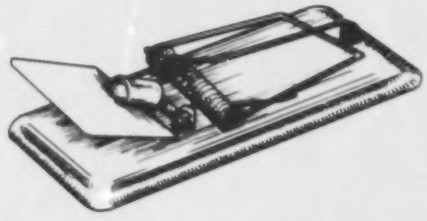


Lesson 6

PESTICIDES — FORMULATIONS AND TOXICITY

Pesticides are killers or destroyers of pests. In agriculture, pesticides include numerous and assorted chemicals and materials that help producers combat a wide variety of pests. Included under pesticides are specific terms closely associated with a particular type of pest, such as:

1) Avicide — destroys birds

2) Fungicide — destroys fungi and bacteria that cause plant diseases

3) Herbicide — kills weeds and unwanted plants

4) Insecticide — kills insects and related arthropods, such as ticks, garden centipedes, spiders, etc.

5) Miticide — destroys mites

6) Nematicide — destroys nematodes

7) Rodenticide — destroys rodents

8) Growth regulators — are not pesticides, but they include a large group of chemicals and materials used to stimulate or inhibit plant growth

Composition of pesticides

Pesticides are made from: 1) inorganic elements, such as sulfur, lead, and mercury. Arsenic was used in some of the earliest fungicides, insecticides, and herbicides. Some elements, such as sulfur, are used today. 2) The botanically derived pesticides are compounds made from certain plants. Several insecticides of plant origin are pyrethrins, rotenone, and nicotine. Rodenticides include red squill and strychnine. 3) Most pesticides used today are synthetic or man-made.

Toxicity of pesticides

Toxicity is the amount of a material that will cause injury or death to an experimental animal (rat, guinea pig, rabbit). For each pesticide, the level of toxicity is fairly uniform for a specific kind of animal but may vary among different kinds of animals. There is, however, a wide range of variation of toxicity with different pesticides to the same kind of animal. For example,

> Malathion is highly toxic to many kinds of insects, but for most warm-blooded animals it has a low level of toxicity. The hazards to man from three organophosphate insecticides vary considerably, with parathion being highly toxic, diazinon is moderately toxic, while malathion presents a low hazard level to humans.

The level of toxicity for a particular pesticide is determined on test animals for oral (mouth), dermal (skin), and inhalation (breathing) routes. Levels for oral toxicity are determined by feeding the test compound. Levels for dermal toxicity are determined by skin exposure tests. Levels for inhalation toxicity are determined in fumigation chambers.

A pesticide's lethal dose is usually noted as "lethal dose 50 value (LD_{50})." This is the amount of toxicant that would kill 50 percent of the test animals under standard laboratory conditions. Toxicity values are based on a single dosage (in milligrams of pesticide per each kilogram of body weight of the animal under test). For example, 10 rabbits are on test for oral toxicity levels for malathion. Each rabbit weighs 2.2 pounds or 1 kilogram. The dosage of (technical,essentially pure) malathion needed to kill 5 rabbits or 50 percent of the test animals is 1188 milligrams or approximately 1/24 of an ounce. Therefore, the oral LD_{50} for malathion when used on rabbits is 1188 mg/kg. Dermal toxicity levels are set after similar testing, except the technical pesticide is applied to the shaved skin of test animals. The dermal toxicity level for malathion under these conditions is greater than 4400 mg/kg. LD_{50} toxicity values are established on test animals in order to determine the degree of hazard of specific pesticides to man.

In the case of humans, the pesticide can enter the body: 1) through ingestion, such as food and water; 2) through the process of respiration, such as breathing fumes, dust, or spray mist; or 3) through absorption through the skin. This can happen when spray droplets or spilled pesticide gets on the exposed body.

Three different categories of pesticides are grouped according to their oral LD_{50} values.*

Group 1. High Toxicity. Pesticides in this group are dangerous to work with and must be handled with extreme caution. Their oral LD_{50} to rats is between 0.1 to 50 mg/kg; therefore, from four to 100 drops of technical pesticide may be lethal to a 150-pound (69 kg) man. The usage label on the package must have the signal words, *Danger* – skull and crossbones; *Poison* in red letters.

Group 2. Moderate Toxicity. Pesticides in this group are moderately dangerous to work with but if you take reasonable precautions, they should present no great hazards. Their oral LD_{50}, to rats, is between 50-500 mg/kg; therefore, from 1 teaspoon to 1 ounce of the technical pesticide may be lethal to a 150-pound man. The container's usage label must have the signal word, *Warning*, on it.

Group 3. Low Toxicity. This group of pesticides is fairly safe to handle and offer minimal hazard to the operator when used with reasonable precautions. Their oral LD_{50}, in rats, is between 500-5,000 mg/kg; therefore, from 1 ounce to 1 pint of technical pesticide may be lethal to a 150-pound man. The usage label on the container must carry the signal word, *Caution*.

Hazards to a pesticide applicator are greatest from inhalation of the particles during mixing and from exposure to the spray and

*Examples of pesticides in each of these groups are given in Lesson 8.

dust particles during application. When several pesticides are registered and you have a choice of effective materials, choose those with the lower toxicity hazards. *The lower the LD_{50} value, the more hazardous the pesticide.*

Formulations of pesticides

The active ingredients in pesticides are either solids, such as crystals or powder, or liquids. The unformulated active ingredients are not used for pest control in agriculture although some ultra low volume (ULV) formulations approach 100 percent active ingredients. To prepare a pesticide for agricultural use, the active ingredient is either ground to fine dust or dissolved in a petroleum solvent and then diluted and mixed with other chemicals until the desired mixture or solution is obtained. This is done to make the materials suitable for mixing in water and for use in spray equipment.

Let's take a look at some of the commonly available pesticide formulations and where they fit into the pest control programs in agriculture:

Emulsifiable concentrates. Liquid formulations normally contain from 2 to 8 pounds of actual pesticide per gallon. The basic technical pesticide is dissolved in a petroleum solvent, then an emulsifier is added so the material will mix with water. It may be available at a 20 percent or 2 E range from a low of 2 or less pounds per gallon up to 8 pounds of pesticide per gallon. *You must read the label and know how much actual pesticide is in each gallon so you can figure the correct dosage rate to use.* Emulsifiable formulations have several advantages. They do not form toxic dusts when mixed with water and they can be used in low volume equipment without plugging screens and nozzles; they save on shipping charges and storage space; and they are easy to measure. There are also several disadvantages. High concentrations of toxic pesticide are potentially hazardous if they are spilled or in case of fire or other accidents. Also, emulsifiable formulations may cause more injury to susceptible plants than wettable powders.

Wettable powders and sprayable powders. These are dry, powdered formulations normally containing 25 to 80 percent actual pesticide. A 25 percent wettable powder contains 0.25 pound, a 50 percent wettable powder contains 0.5 pound, and a 75 percent wettable powder contains 0.75 pound of actual pesticide per pound. The basic technical pesticide is finely ground and is mixed with a clay-like diluent. Wetting agents are added to facilitate its mixing with water. Wettable and sprayable powder formulations are relatively safe on susceptible plants, and provide a suitable formulation for those pesticides for which a suitable solvent is not available. They do offer an additional dust hazard to the operator when mixing. There is need for a dry storage of these formulations. Wettable powders will cause problems of plugging sprayer screens and nozzles if used with poor agitation in the spray tank.

Flowables. Liquid formulations normally contain four or more pounds of actual pesticide per gallon and are composed mainly of finely ground pesticide suspended in liquid. Contents of the flowable formulation are similar to the wettable powder type except for the liquid base. The advantage of flowable formulations is the ease in measuring dosage rates. They lack dust particles, so mixing and handling is less hazardous.

Granules. Dry, granulated formulations normally contain from 2 to 15 percent active pesticide. Various types of base (clay, ground corn cobs, etc.) are used for the granules or diluent. The insecticide is applied and adheres to the particles. The low amounts of toxic pesticide in a pound of granules reduces the hazard of handling highly toxic substances. Since the formulation is without dust particles and flows freely as does fertilizer, this formulation is well suited to be applied with applicators mounted on planters and other farm machinery. It offers a reasonably safe way to apply toxic materials without danger of spray or dust drift.

Dusts. These dry, powdered formulations contain from 0.5 to 10 percent active pesticide. Most of the material in the package of dust is an inert clay-type diluent. Dust formulations are not good buys. There is a great loss due to drift, they normally do not adhere to the plants as well as sprays, and drift increases the hazard to both the operator and the environment. Dust formulations are convenient only for small jobs and for use in home gardens.

Baits. They contain a low percentage of active toxicant or poison and high percentages of an attractant or food. Common types of bait are rat and mouse bait, cutworm bait, fly bait, and ant bait. The bait is placed or scattered where the target animal feeds; the bait must be eaten before it will kill the pest. (Hazards are children, pets, or other animals eating the bait.)

Fumigants. Most fumigants are liquids but they can produce poisonous fumes when they are released in air or soil. There are two important needs for fumigants in agriculture — to rid stored grain of insect pests and for soil treatment to control nematodes and certain plant diseases.

Aerosols. Aerosol formulations contain a low percentage of active pesticide mixed with a propellent that forces the contents from the container as a mist or spray. These formulations are packaged in pressurized cans or cylinders. The size of the cans (bombs) intended for home garden and general household insect control is generally in the 12 to 16 ounce range. The aerosol cylinders designed for commercial and greenhouse use are commonly available in a 4 to 10 pound size range.

Aerosols are convenient to use since no measuring or mixing of ingredients is required. They are ready to use as purchased. The aerosol "bomb" has been widely accepted as a convenient way to kill household insect pests. Control of insects is the major use of aerosol formulations.

What happens to pesticides?

Several things can happen to a pesticide, depending upon which one it is, and the manner in which it is applied, its effect on the target pest, and how it may affect the environment.

During application

Sprays and dusts end up in many locations. Under ideal weather conditions, most of the pesticide reaches the target plants; however, measurable amounts stay in the air and float from a few minutes to a few days and can be moved long distances. A pesticide will eventually alight on soil, water, plants, or objects. If the pesticide is degradable and has a low order of toxicity, this is not a serious hazard to the environment. If it is a highly toxic material or if the material is persistent, hazardous conditions exist anywhere the spray particles drift.

The pesticide that sticks to the plants may remain toxic to insects or fungi for a few hours, a few days, a month, or all season depending on the pesticide used and its exposure to weather conditions. For example, malathion is a short-residual insecticide, it degrades rapidly and its effectiveness as an insect killer lasts between 1 to 3 days. The insecticide, carbaryl, and the fungicide, captan, degrade more slowly than malathion and remain active for about 1 week. These materials are not particularly hazardous unless they are highly toxic. Then they could present potential hazards for approximately 1 week. The hazards from the application of pesticides are from: 1) *highly toxic pesticides*, such as parathion, or a highly volatile herbicide that can easily drift to nearby fields; or 2) persistent pesticides that degrade very slowly and remain toxic over long periods of time, such as lead arsenate, strychnine, and endrin. Hazardous effects can show up soon after spraying or they can be delayed and show up in areas some distance from the application site. For example, is the portion of pesticide on the target crop hazardous? It may be hazardous to man, domestic animals, and wildlife for some time after application. The degree of hazard and time it remains hazardous depends upon the individual pesticide used. Now is when the registration label becomes an important factor. The safe interval from time of application until the crop can be harvested is stated on the label (Lesson 8).

Once an insecticide is on a plant or animal, it may start degrading into nontoxic substances and slowly disappear through weathering. Systemic pesticides find their way into the plant or animal and move within to other locations and are not exposed to the weather. Systemic pesticides are discussed on page 62.

Soil applications

The application of certain herbicides and insecticides on or in the soil is a common agricultural practice. With soil site application: 1) the loss of insecticide into the air is reduced, especially when granular formulations are used or when the pesticide is

introduced directly into the soil; and 2) contamination of water sources and runoff into streams is normally minimal since the pesticide is soon bound to soil particles and moves very little in the soil.

However, a few of the problems associated with soil application include: 1) movement of pesticide on soil particles by both wind and water erosion of the soil; and 2) persistent pesticides bound onto soil particles often degrade much slower than those exposed to weathering. This condition could influence the level of pesticide residue on future crops grown in the treated fields. For example,

SYSTEMIC PESTICIDE

The remaining pesticide in the soil could affect the germination of seed or growth of a susceptible crop if a herbicide residue remains. Contamination of alfalfa is very likely if it is grown on soil treated with a persistent insecticide such as aldrin a year or more previously.

Systemic pesticides

Many herbicides, some insecticides, and a few fungicides are systemic in nature. This means that the pesticide can be taken into the plant or animal from the site of application and can then move to other parts of the plant or animal through the plant system or blood stream. For example,

You can treat cattle by spraying or using a pour-on method for applying several approved insecticides to control cattle grubs. Some of the insecticide will penetrate the skin and enter the body of the treated animal. The amount of insecticide that gets into the animal's system is sufficient to kill the grubs but will not harm the animal.

Phorate and disulfoton are systemic insecticides widely used by potato growers at planting time. Granular formations are applied in the soil in the row. As the plants establish roots, the insecticide is picked up and moved up through the plant to the leaves. Insects that chew on the leaves or suck the sap, such as flea beetles and leafhoppers, are thereby killed.

Pesticides sprayed on the leaves may also have systemic action. Many of the herbicides work in this manner. The herbicide enters the system of the plant through the cuticle and is then transported to the newly developing tips, stem, and roots.

Before any systemic is used, you must know how long it will remain active (toxic) in the plant. You cannot treat alfalfa, corn, potatoes, etc., with a systemic poison to control the pests and then harvest the crops for food or feed with the poison still present. It again becomes important to read the label. The time interval — from application of the pesticide until it is safe to harvest the crop — is given. Some systemic pesticides degrade within a plant in a few days, while others continue to be active up to 1 month or 6 weeks. *Check the label, don't gues*

Compatibility of pesticides

There will be many situations when two or more pesticides, or a pesticide and fertilizer, must be applied. Can two or more materials be combined and applied at the same time? This practice would save you time and also the cost of another application. Some chemicals can be mixed together safely and applied together, thereby saving time and money, and still give you the full benefit of the materials. Chemicals are said to be compatible if two or more can be mixed together safely and can be used at the same time.

Not all combinations of pesticides are compatible — some cannot be used in combination. These mixtures are incompatible because either they will not mix together chemically, they mix well but their effect on the pests is reduced, or they injure the crop.

Pesticide labels usually state incompatibility problems. Before mixing pesticides or a pesticide and a fertilizer, be sure the combination is compatible (and approved for use). If you are unsure of the safety of any pesticide mixture, don't use it until you check with your pesticide dealer or county agent. Don't guess.

Resistance of pests to pesticides

COLORADO POTATO BEETLE

Regardless of how good a pesticide is or how well it is used, 100 percent control is seldom, if ever, obtained. Some pests do not come in contact with the pesticide while others are more tolerant to the pesticide due to their physical makeup. Each time a pesticide is used, pests are killed which are most susceptible to that pesticide. Those with some tolerance often survive. Insects that do survive are more resistant than those that are killed. By using the same pesticide time and again, the resistant pests that survive will eventually reach a high level of resistance to that chemical. If this level of resistance is passed on to the offspring, the entire population of the pest may become resistant to that pesticide. The pesticide then becomes ineffective against that pest. For example,

> When the Colorado potato beetle started making its comeback in the Eastern states a few years ago, carbaryl (Sevin) gave effective control, but in many localities carbaryl no longer is effective due to the resistance that the beetle population has developed to the insecticide.

Everyone shows various degrees of resistance to poison ivy, contaminated water, bee stings, diseases, and even poisons. Americans visiting tropical countries frequently become ill with stomach disorders from drinking water; however, the natives that drink the same water do not exhibit these symptoms because they are resistant to the bacteria in the water.

Many insects and mites have developed resistance to many insecticides and miticides. Rats have developed resistance to

certain anticoagulant baits. If the pesticide is not doing the job, it may be because the pest is resistant to it.

Pesticides vary in their toxicity level. When alternatives are available, and their efficacy and practicality are similar, choose the one that is least likely to poison you or other organisms.

When you have to choose between numerous formulations of the same pesticide, or when you have just one choice, select the formulation that best fits your equipment and operation. Keep in mind the possible hazards associated with the various formulations in storage, handling, and potential pollution.

Some pesticides, under certain conditions, can create greater problems than the pest problems they are used to correct. You must keep this from happening. Use persistent or highly toxic pesticides only when absolutely needed.

Lesson 6 Quiz

PESTICIDES — FORMULATIONS AND TOXICITY

Answer the following questions True (T) or False (F).

____ 1) A pesticide can be defined as a material that kills pests.

____ 2) A rodenticide is a material that destroys weeds.

____ 3) Most of our presently used pesticides are man made.

____ 4) Poisoning of humans can occur by ingestion, skin absorption, and by inhalation.

____ 5) The only hazard to a pesticide applicator is from inhalation of particles during mixing operations.

____ 6) Most farmers use dusts because dust formulations are cheapest and are least hazardous to the environment.

____ 7) All pesticides remain toxic the same length of time after they are deposited on the plant.

____ 8) Once a systemic pesticide enters a plant or animal, it is no longer toxic to humans and we can forget about it.

____ 9) Not all combinations of pesticides can be safely mixed together.

____10) Highly toxic pesticides should be used only when absolutely needed.

Circle correct answer.

11) Pesticides offer the greatest danger to the applicator when he:
   A) Is flushing and cleaning the sprayer
   B) During the mixing and application of the pesticide
   C) When he is checking the control results a few days after application
   D) Eating lunch
   E) Swimming in farm pond

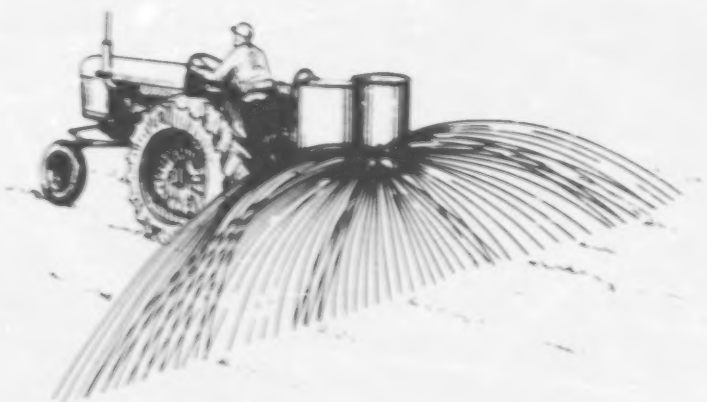
12) An emulsifiable concentrate formulation of a pesticide used at the rate of one pound actual pesticide per acre is:
   A) More effective
   B) Less effective
   C) About the same effectiveness as a wettable powder formulation of the same material used at the same rate
   D) Worthless
   E) None of these

13) During the application of a spray or dust to a field or orchard:
   A) Only part of the material reaches and stays on the plants
   B) All of the material reaches and stays on the plants
   C) None of the material reaches the plants
   D) All drifts to neighbor's property
   E) Most enters the atmosphere

14) Pesticides applied into the soil can be expected to degrade (break down):
   A) Slower
   B) Faster
   C) At about the same rate as the same material applied on top of the soil
   D) At unknown rate
   E) None of these

15) When a new pesticide is introduced for use it will be effective:
   A) Forever
   B) Until pests develop resistance to it
   C) For only 2 years
   D) For at least 5 years
   E) For a minimum of 10 years

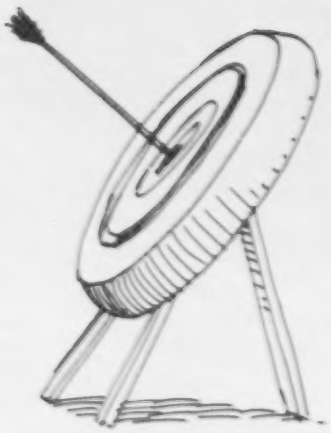
Answers:
1. T
2. F
3. T
4. T
5. F
6. F
7. F
8. F
9. T
10. T
11. B
12. C
13. A
14. A
15. B



Lesson 7

PESTICIDE APPLICATION EQUIPMENT

Shaking an old sock filled with bug dust over potato plants was one way that pesticides were applied in the past. Today's agriculture requires modern equipment to apply a variety of pesticides. Pesticides may be applied as sprays, dusts, granules, gases (vapors), fogs, baits, rubs, or dips. The vast array of equipment on the market must be matched to the pesticide material as well as the size and type of job to be done. To do an effective, safe, and efficient application, the equipment must be properly adjusted, calibrated, operated, and maintained. To obtain desired control without harming the environment, read and follow all label directions.



Targets

The target is the area or item to be treated. It may be a spot, such as thistles in a pasture field. It may be an entire field, such as weed control in corn (broadcast treatment). The target may be a band, such as in-row treatment of corn rootworm. Fruit or shade trees, grapevines, shrubs, or turf areas may be the treated items. The target may also be an enclosure, such as a greenhouse or bin of grain, or the target may even be an animal. The goal may be to kill all vegetation in a fence line, driveway, or ditch. Treatment may also be directed at waterways, lakes, or ponds for aquatic weed control.

Application equipment

The equipment or device used to apply the pesticide must dispense the material so that it is spread on the target at the proper rate to obtain desired control. Always follow label directions. The applicator could be an aerosol can, hand equipment, power equipment, or even an aerial applicator. The equipment may be carried, towed, or self-propelled. A company in South America designed a sprayer that is carried by a mule and used to spray coffee plants on steep mountains.

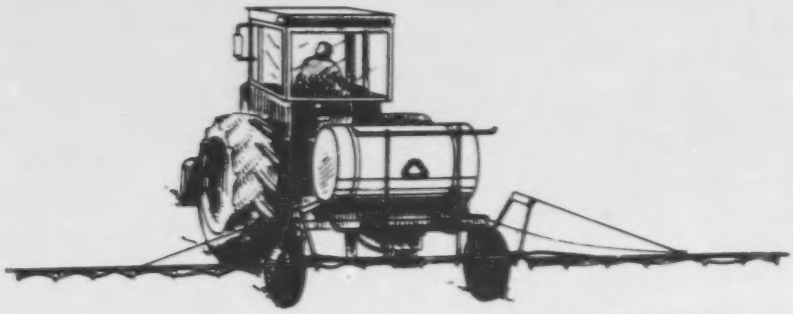
The most common type of pesticide applicator in the United States is the sprayer, accounting for about 90 percent of all units. A hydraulic (liquid) sprayer uses water as a diluent and as a carrier for the pesticide, except in ultra-low-volume spraying where the pesticide is applied directly as formulated. In any case, pressure from either a pump or compressed gas is used to atomize the spray mix at the nozzle. Hydraulic sprayers are usually used for weed control.

The air-blast (or mist) sprayer uses both water and air. The pesticide is diluted with water (except with ultra-low-volume spraying) as with the hydraulic sprayer, but uses both water and air as a carrier. Spray droplets are formed with nozzles or other methods and delivered to the target by an air stream (blast). These air-blast sprayers are typically used for disease and insect control on fruits and vegetables.

Granular applicators are designed to apply pesticides formulated as granules in band or broadcast treatments. Band ap-

plicators are often combined with planting or cultivating equipment to place a band of pesticide over a row. Broadcast applicators may also be combined with other equipment; for example, a granular broadcast applicator may be mounted on the front of a disc or harrow when incorporation (mixing) with the soil is desired. Granules may also be knifed into the soil.

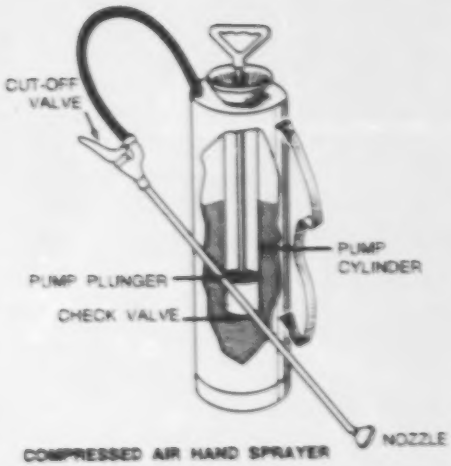
Other pesticide applicators include irrigation systems, animal rubs, dipping vats, and baits.



HYDRAULIC BOOM SPRAYER

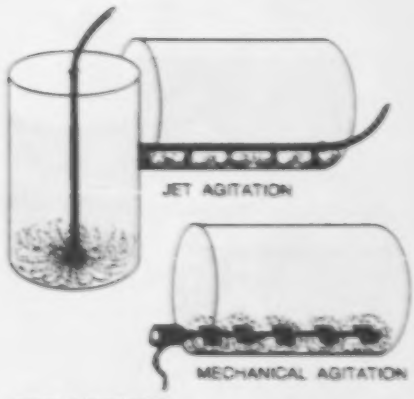
Hydraulic sprayers

Hydraulic sprayers are used for spot, band, and broadcast spraying. The sprayer may have one or several nozzles on a boom or in a cluster. The nozzles may be permanently mounted or hand held. Hydraulic sprayers are usually powered and can be towed, self-propelled, or mounted on other equipment, including aircraft. However, for small jobs a hand-carried compressed air sprayer can be used.



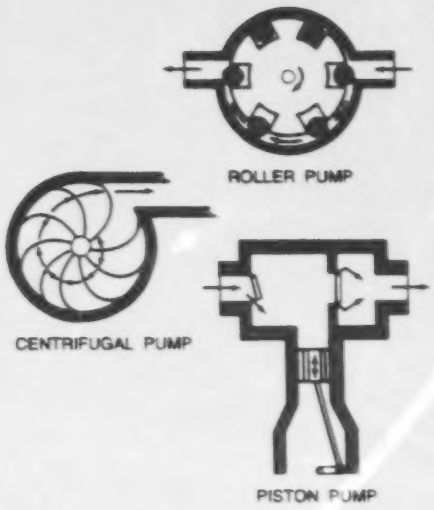
COMPRESSED AIR HAND SPRAYER

Since hydraulic sprayers use water to dilute and carry the pesticide, a tank is necessary to contain the spray mix. The tank should be large enough to eliminate frequent refills but not so large that the weight (when filled) becomes a problem. The tank should be made or coated with a material that does not corrode and can be easily cleaned. Corrosion and dirt will clog screens and nozzles and increase wear. Large tanks should have a drain opening in the bottom to aid cleaning and draining. A large top opening is useful for filling, cleaning, and inspection; however, the opening should have a cover to prevent spillage. If wettable powders are used, there should be an agitator, either jet or paddles, in the tank to insure uniform mixing of the pesticide(s) and water. Constant mixing is necessary to prevent settling of the powders; otherwise there is a nonuniform spray mixture resulting in uneven application of chemicals.



TANK AGITATORS

Hydraulic sprayers usually have roller, centrifugal (impeller), or piston pumps. Since most hydraulic farm sprayers are boom sprayers for weed control, a low pressure pump is adequate so roller and centrifugal pumps are very popular. Weed spraying is usually done at 10 to 40 psi. Where wettable powders are used, the centrifugal pump is especially good since wear is slow and there is plenty of high-volume capacity for jet agitation.



SPRAYER PUMPS

Roller pumps are widely used due to their low cost, wide range of pressures (available up to 300 psi), and because they can be directly mounted on a PTO shaft. Their volume is adequate for most weed sprayers. Roller pumps wear relatively fast, especially when pumping the abrasive wettable powders. However, rebuilding kits are available to replace the rollers, gaskets, and, in some cases, the seals. Rebuilding a roller pump is a simple job that can usually be completed in about half an hour using simple tools.

Centrifugal pumps, although somewhat more expensive initially, are long lasting. Since the pressure is produced by an impeller rather than one part moving against another, wear is much slower than roller or piston pumps, especially with wettable powders. Centrifugal pumps have high volume capacity (up to 125 gallons per minute) but their low pressures limit them to applications of 50 psi or less (for single impeller units). Centrifugal pumps are built to operate in the 1500-3000 rpm range. Therefore, they cannot be directly mounted on a PTO shaft but must be driven through a speed increaser. These pumps' performance are poor if the inlet is restricted in any way; instead of using a suction screen, place an in-line screen in the outlet (pressure) line of the pump.

Piston pumps are high pressure units operating up to 600 psi or more. They are wear resistant but low in volume and high in cost. They can operate at PTO speeds but the size of the multi-cylinder models (for higher volumes) may not permit direct mounting. However, they can be mounted on the sprayer and driven directly through a PTO shaft. A piston pump produces a pulsating output so a small surge tank should be used to smooth out the pulses. These pumps are used where high pressure is needed, such as a handgun for shade tree spraying or boom sprayers for insecticides and fungicides.

NOZZLE PATTERNS

Nozzles are a very important part of a sprayer. They control the amount of material applied, the formation of the droplets, the distribution of the droplets (pattern), and thus the uniformity of applications.

Nozzle tips are available in various materials including brass, nylon, and stainless steel. Wear destroys the proper working of a nozzle so worn nozzles should be replaced. To reduce wear rate, especially with wettable powder, use nozzle tips made of a hard, wear-resistant material such as stainless steel. The purchase price is more, but in the long run, stainless steel may be cheaper. Never use brass tips to apply wettable powders because they wear out fast.

There are many spray patterns available. The flat-fan nozzle produces a fairly coarse spray in a fan pattern that provides uniformity with proper pattern overlap along a boom. It is well suited to most weed control practices and some insect control where foliage penetration is not required. The fans are available in various spray angles; a wide angle nozzle can be operated

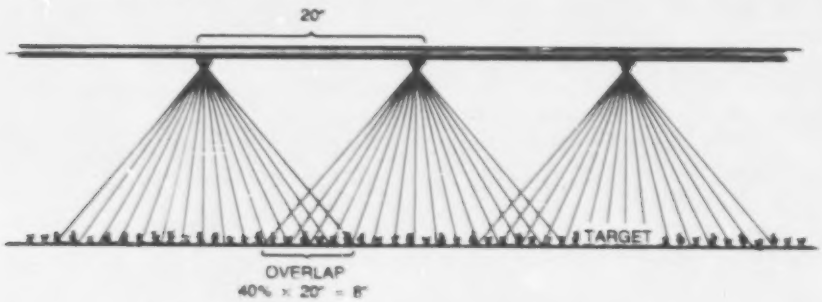
closer to the ground to minimize drift. Normal operating pressure is 20 to 40 psi.

The flooding spray nozzle can spray a wide surface while operating close to the sprayed surface. These nozzles are placed at 40-inch spacings on a boom. Operating at 10 to 20 psi on a boom, the flooding pattern will produce satisfactory broadcast distribution for weed control. It is resistant to drift and recommended where damage from drift is likely. The flooding nozzle is also ideal for applying post-emergence chemicals to the middle row of growing crops because of the low discharge level.

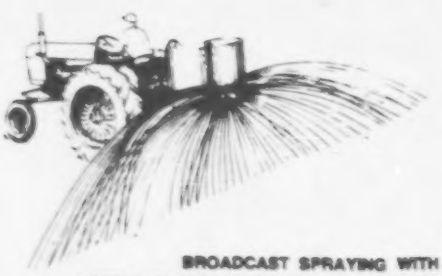
Both the hollow and solid-cone nozzles are designed to operate at high pressure (40-400 psi) and thus break up the spray into smaller droplets. This provides more complete coverage of the sprayed area, such as a plant; however, the smaller, lighter droplets may cause fogging or drift. Cone nozzles are used for insecticides and fungicides where complete coverage and foliage penetration are needed and some drifting is not as great a hazard.

The size of the nozzle orifice (opening) and the pressure control the discharge rate of each nozzle. Booms can be equipped with tips to provide from 2 to 150 gallons per acre depending on nozzle size, spacing, pressure, and driving speed.

The best nozzle arrangement for broadcast application is on a boom. This setup can provide uniform application required for good weed control. Adjust the boom height so patterns overlap on each side (about 40 percent spacing between the nozzles). For example, if your nozzles are 20 inches apart, the patterns should overlap 8 inches.



TYPICAL BOOM SETUP WITH PROPER PATTERN OVERLAP



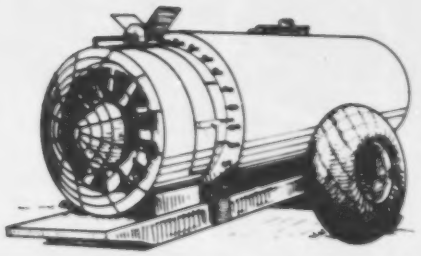
BROADCAST SPRAYING WITH NOZZLE CLUSTER (BOOMLESS) SPRAYER

Clusters of nozzles do not provide as good a distribution, even in still air. A slight wind can produce serious drift problems. One of the few places they may be used is where you want to spray past obstructions, such as trees in a park or fence line.

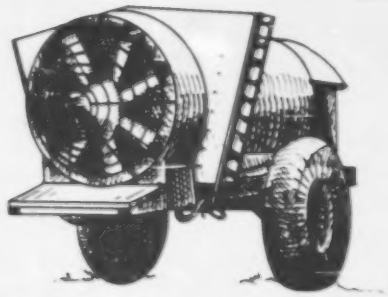
Single nozzles or up to four in a group may be hand held in a gun arrangement. The gun may have a pistol valve for on-off control. These are used for spot treatment of weeds, tree and shrub spraying, or animal treatment.

Hydraulic spraying may also be combined with other opera-

HAND SPRAY GUNS



TYPICAL AIR-BLAST ORCHARD SPRAYER



PTO POWERED AIR-BLAST SPRAYER FOR ROW CROPS

tions. For example, a tillage tool may be equipped with nozzles for pesticide application; incorporating it with soil and preparing the seedbed in one trip over the field. Or the pesticide may be applied through an irrigation system.

Air-blast sprayers

With air-blast (mist) sprayers, the pesticide is also mixed with water. Tank and agitation requirements are similar to hydraulic sprayers. The spray mix is also atomized into droplets with nozzles or similar devices. The difference is that a high-volume fan is used to produce an air stream that carries the droplets to the target area. Since the air is the delivery system and provides the transport energy, the individual droplets can be small. The air capacity of the fan must be capable of displacing the volume of air in the tree or space being sprayed with the air from the sprayer which carries the spray droplets. The droplets are deposited on the target, usually trees or row crops, according to plant size, shape, and distance from the sprayer.

Wind is the biggest problem with air spraying. Good coverage is very difficult in winds over five miles per hour. Many people operate at night or very early in the morning to take advantage of the generally calmer air conditions. Also the relative humidity is higher at night; this reduces evaporation of the small droplets, especially important with low-volume application.

Air-blast sprayers may be towed or tractor mounted on the three-point hitch. The smaller mounted and trailer models are PTO powered. The large units have their own engine. The air may be discharged from one or both sides. Both the shape of the air opening and the placing of the droplets in the air stream must be matched to the job (i.e., orchard, vineyard, row crops).

Nozzles are very important. Air-blast sprayers are used primarily for disease and insect control on plants; therefore, the spray must be broken into small droplets to insure an adequate number of droplets for complete coverage. For this reason, air sprayers are equipped with cone nozzle tips. Air-blast sprayers are also used to apply growth regulators to crops.

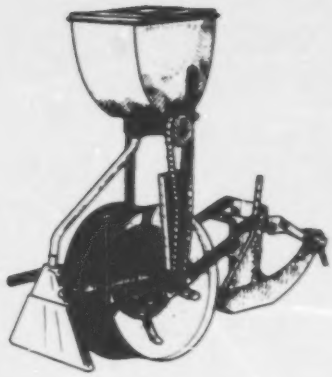
Most air-blast sprayers require high pressure and therefore are usually equipped with piston or multi-stage centrifugal pumps. Either type will handle wettable powders with minimum wear.

Granular Applicators

Granular applicators are relatively new and their use is increasing. The granules are manufactured for direct application and thus no additional mixing is needed. Refill time is short since extra granules can be taken to the treatment site.

Granular applicators are available for either band or broadcast coverage. They may be operated as separate units but are often used as attachments on other equipment, such as planters or discs to combine operations.

GRANULAR BROADCAST APPLICATOR ON DISK



GRANULAR BAND APPLICATOR ON PLANTER

Granular applicators usually use gravity feed, a rotating feed valve or agitator, and an adjustable opening to regulate flow. Band applicators use hoses or tubes with deflectors on the bottom; broadcast units use a fan or spinner to spread the granules. The fan and spinner units are convenient to use around trees, especially in orchards; however, they should be used only when there is little or no wind. The application rate is also affected by the ground speed, granule size, shape and density, roughness of the field, and even relative humidity and temperature of the air. To assure accurate application rate, each unit must be calibrated with the specific material to be applied. Where band applicators are used on row crop planters, each individual unit must be calibrated to insure accurate application.

Dusters

Dusters account for a small percentage of all powered pesticide equipment. Their use is confined largely to small farms in the Southeast and Appalachian areas. Their major use is disease and insect control on vegetables and field crops.

Dusters consist of three major parts; hopper with adjustable flow regulator, fan distribution system, and power unit. The power may come from an auxiliary engine or from the tractor PTO.

Hoppers are available in various sizes; the amount of material they can hold depends on the density of the dust. Hopper agitators are necessary to prevent bridging. The flow regulators are adjustable to deliver dust at rates of 5 to 50 pounds per acre.

Centrifugal fans are used in the fan distribution system. Because these fans must operate at 2,000 to 3,000 rpm's, they cannot be directly driven from tractor PTO. The dust is distributed through hoses with nozzles on the ends. The number of nozzles varies with the application.

A good time to apply dust is early morning when the wind is calm and dew will help to make the dust stick to the plants. Do not attempt to apply dust in winds greater than five miles

per hour for both your protection and the protection of the surrounding area.

Miscellaneous equipment

There are a number of items for specific applications. These include:

1) Animal rubs, walk-through sprayers, and dipping vats for parasite control.

2) Baits for rodents and predators.

3) Foggers for structural pest control and insect control in open spaces.

4) Irrigation systems for greenhouses and field crops.

Maintenance

Pesticide equipment requires maintenance for continued effective and efficient operation. Cleaning is the most important. Many of the pesticides are corrosive to materials used in applicators. Therefore, equipment should be emptied and cleaned immediately after application. Do not mix more than is needed or can be used so you always end the day with an empty tank.

Flush sprayers after each day's use with water inside and out to prevent accumulation of chemicals. When you change chemicals, or finish spraying for the season, clean the sprayer thoroughly with a cleaning agent. Choose the washing area carefully; avoid contamination of water supplies and injury to plants or crops. Don't make puddles that might be accessible to children, pets, farm animals, or wildlife.

CLEAN NOZZLE TIPS WITH A SOFT BRUSH

The following steps are suggested for thorough cleaning of a sprayer:

1) Hose down the inside of the tank and partially fill it. Flush the cleaning water through the nozzles by operating the sprayer.

2) Repeat step 1.

3) Remove nozzle tips and screens. Clean them in strong detergent solution or kerosene using a soft brush such as an old toothbrush. Do not damage nozzles by using wire, knife, or other hard objects that might scratch the orifice.

4) Fill the tank with 30 to 40 gallons of water and add one pound of laundry detergent powder or equivalent in liquid form to form a sudsy solution.

5) Operate the pump to circulate the detergent solution through the sprayer for about ½ hour. Then flush it out through the boom.

6) Fill tank with 30 to 40 gallons of clean water and flush through the boom.

If you want to clean 2,4-D or an organophosphate from the sprayer, do the following BEFORE step 6*.

*Caution — since only a trace of 2,4-D will damage some plants, it may be risky to use a sprayer that has been used to apply 2,4-D to treat these sensitive plants.

Add one pound of activated powdered charcoal with detergent, OR:

1) Following step 5; replace the nozzles.

2) Fill tank with 30 to 40 gallons of water and add two quarts of household ammonia.

3) Operate pump for 5 minutes to mix and circulate solution. Flush small amount through nozzles and let remainder in sprayer overnight.

4) Next morning flush remainder through system and complete step 6 above.

Granular applicators and dusters must also be cleaned following use. The following steps are recommended:

1) Remove all pesticide from the applicator. You may have to disassemble certain parts to do a thorough job.

2) Thoroughly clean the inside of the hopper.

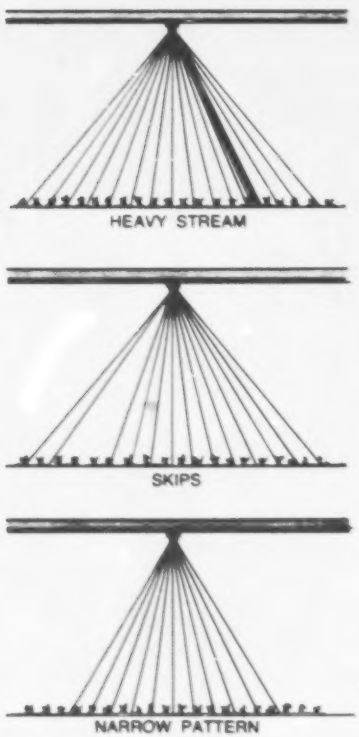
3) Clean rusted or corroded parts with sandpaper, emery cloth, or wire brush. Paint with rust preventive primer and machinery paint.

4) Wipe inside and outside with coat of oil. Oil or grease bearings, if appropriate.

5) Thoroughly clean and oil flow-control valve and adjustment.

6) If steel tubes are used, clean and oil them.

7) Before using next time, wipe off oil that may come in contact with granules or dust.



SYMPTOMS OF WORN NOZZLES

It is important to check sprayers for nozzle wear. Compare patterns for shape and uniformity and check flow-rates. Variations in either indicate wear and the need to replace nozzle tips or discs (and whirlplates, if used).

Maintain equipment so it does not deteriorate during storage. These maintenance efforts will save you time and frustration in getting the equipment into proper working order next season.

All parts of a sprayer, especially the pump, should be protected from deterioration during storage. The sprayer should be cleaned inside and out. If your sprayer has no rubber parts, put 2 to 5 gallons of new or used motor oil in the tank prior to final flushing. As the water is pumped from the sprayer, the oil will leave a protective film on the inside of the tank, pump, and plumbing. Remove nozzle tips and screens and store them in a can of light oil or kerosene. Tape nozzle openings closed to prevent entry of dirt and insects. Drain all parts to prevent freeze damage. If the sprayer contains rubber parts, the pump should still be protected. Disconnect the pump and put two

tablespoons of oil in each of the inlet and outlet connections. If the pump has rubber parts, use radiator rust-inhibitor instead of oil. Rotate the pump shaft by hand to coat the inside surfaces.

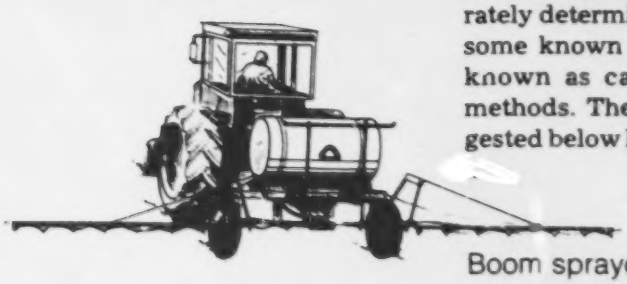
Granular applicators and dusters — cleaned according to the instructions — will be adequately prepared for storage.

If any equipment has an auxiliary engine, prepare it for winter storage. Thoroughly clean the outside of air-cooled engines. Completely drain or add anti-freeze solution to water-cooled engines. Either drain fuel system or add a stabilizer. Remove spark plugs and pour one ounce of rust preventive oil into each cylinder. Turn engine shaft four or five revolutions to distribute the oil; do not start engine.

Store equipment in clean, dry building. Check for worn, deteriorated or broken parts; order replacements early.

Calibration

Equipment is manufactured to be adjustable for application rate. Charts or tables may be provided to guide the operator in making the settings. However, these rates are only approximate and may change due to particular situations. The way to accurately determine the application rate is to make a check run on some known area and measure the amount applied. This is known as calibration. Calibration can be done by many methods. The important thing is to do it. The methods suggested below have proved to be reasonably accurate and easy to



Boom sprayers

The following checks are recommended before you use a boom sprayer:

Before calibrating:

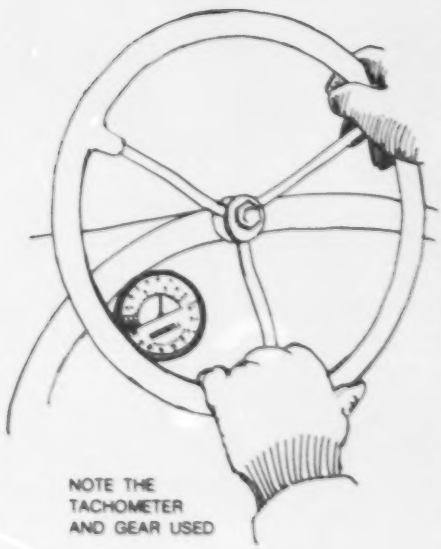
1) Thoroughly clean all nozzles, screens, etc., to insure proper operation.

2) Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.

3) Check the spray patterns of all nozzles for uniformity. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform patterns or do not fill containers at the same rate.

4) Select an operating speed (generally 3 to 5 mph). Note the tachometer reading and gear used. When spraying, be sure to use the same speed as used for calibrating.

5) Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying.



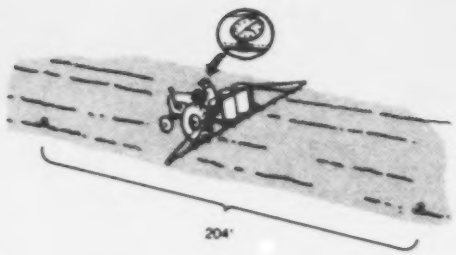
Calibrating with a jar. Either a special calibration jar or a homemade one can be used. If you buy one, carefully follow the manufacturer's instructions.

Make accurate speed and pressure readings and jar measurements. Make several checks. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres.

Any quart or larger container, such as a jar or measuring cup if marked in fluid ounces, can be easily used in the following manner:

1) Measure a course according to nozzle spacing as follows:

Nozzle spacing (in.)	16	20	24	28	32	36	40
Course length (ft.)	255	204	170	146	127	113	102



TYPICAL CALIBRATION COURSE

2) Measure the time in seconds it takes the sprayer to cover the measured distance at the desired speed. Average several runs.

3) With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.

4) Determine the average output per nozzle in ounces. The ounces per nozzle equals the gallons per acre applied for one nozzle per spacing. If two (or three) nozzles per spacing are used, multiply the average nozzle output by two (or three) to get the gallons applied per acre.

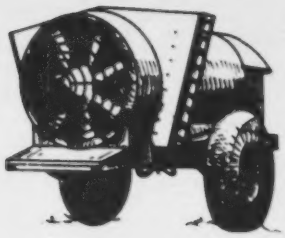
Band sprayers

If band spraying is used, use the method of calibration above. The rates of application, as well as figures given in tables by nozzle manufacturers, are for broadcast spraying and must be adjusted for the particular band width and row spacing used. Calculate the number of gallons applied per treated acre in the band by using the following formula:

$$\text{Gallons/Treated acre} = \text{Gallons/Field acre} \times \frac{\text{Row spacing (in inches)}}{\text{Band width (in inches)}}$$

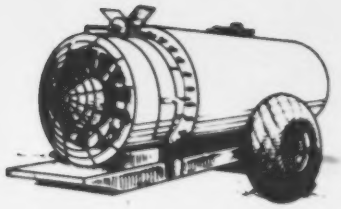
For example, assume application is 5 gallons per field acre in 12-inch bands on 36-inch rows. The rate per treated acre is 15 gallons (5 gallons × 36/12). In other words, one-third of the field area is treated.

If your sprayer has a 150-gallon tank and it applies 15 gallons per acre, each tankful will cover 10 acres (150 ÷ 15). If two pounds of chemical per acre are recommended, you should add 20 pounds (10 acres × 2 pounds per acre) to the tank.



Air-blast sprayers

Air-blast sprayers must be calibrated to insure proper application rate. With low volume (less than 100 gallons per acre) spraying, uniform and accurate application are more important. Consult your dealer for correct nozzle size and distribution.



An air-blast sprayer can be checked using the following steps:

1) Select a plot of known area such as an acre or some part of an acre.* Don't use less than ¼ acre.

2) Fill sprayer tank full or to some known level with water only.

3) Spray check plot only, being careful not to lose water by splashing, etc.

4) Measure the amount of water required to refill tank to previous level. Be sure to park sprayer in same position.

5) Calculate the gallons per acre.

For example, if 28 gallons are required to refill the tank after spraying a ½-acre plot, the application rate is 56 gallons per acre.

Adjusting application rates. The application rate can be increased by slowing the tractor speed, increasing the pressure, or using larger nozzles. For decreasing the application rate, speed up the tractor, decrease the pressure, or use smaller nozzles. Some sprayers have other means of adjustment; check operator's manual.

Repeat calibration runs until the desired rate of application is achieved. Then, continually check the rate as you make the application. Changes can occur.

Adding the chemical. The amount of chemical needed per tankful depends on the recommended rate and the number of acres you can treat per tank of spray.

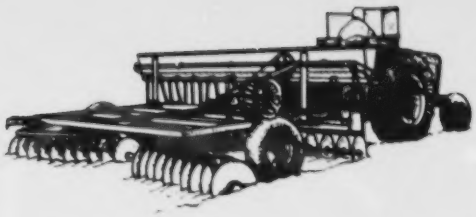
To determine the number of treated acres per tank, divide the tank capacity (gallons) by the application rate (gallons per acre). Multiply the number of treated acres per tankful by the recommended pesticide rate to find the amount of chemical to add to the tank. See example. *

* The tank volume is 140 gallons and the sprayer delivers at the rate of 20 gallons per acre. Thus one tank load would cover 7 acres. If you want to apply material at the rate of 3 pounds per acre, how much must you add to each tank load?
Answer: 21 pounds.

Granular applicators

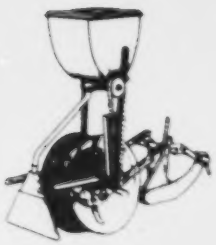
Calibration of granular applicators is somewhat different because they must be calibrated with the same material that is to be applied. Therefore, the check must provide a means for collecting and weighing the granules.

*An acre is 43,560 square feet. In an orchard you can use tree spacings as measurements.



For broadcast applicators, select a plot of known area of an acre or less. Disconnect the spreading mechanism (if one is used) and attach a catchpan, plastic or other bag, or any appropriate container to catch the granules. Operate the applicator at the desired settings and ground speed with the same pesticide to be applied. Be careful to operate over only the measured plot and to catch all the material that flows through the unit.

For example, if you are spreading a 30-foot swath and want to use a 1/4-acre plot, you would drive 363 ft. [1/4 of (43,560 ÷ 30)]. Assume you catch and measure 10 pounds of granules. The application rate would be 40 pounds per acre (10 × 4). Adjust setting and rerun until desired rate is achieved.



Since granular band applicators cover such a small area, it is easier to calibrate by band or row length. Disconnect the drop tubes and collect the granules in a bag or can while operating 1,000 feet. The granules collected should be measured by weight since volume measurements may cause errors due to variation in density of the materials. The pesticide will amount to only a few ounces; this can be weighed on a postal scale or a no-longer-needed baby scale. Check the amount actually delivered with the recommended rate. If the recommendation is given in pounds per acre rather than ounces per row length, refer to Table 1 for conversion. For example, if 7 pounds of chemical per acre is recommended on 38-inch rows, you should collect 8.1 ounces while your equipment moves 1,000 feet. Adjust the applicators and repeat calibration runs until the desired delivery rate is obtained from all applicators.

Table 1 — Band application of granular pesticides

Row spacing (inches)	Row length per acre (ft.)	Weight (ounces) per 1,000 feet of row			
		1 lb./A	5 lb./A	7 lb./A	10 lb./A
20	26,136	0.61	3.1	4.3	6.1
24	21,780	0.73	3.7	5.1	7.3
28	18,669	0.86	4.3	6.0	8.6
30	17,424	0.92	4.6	6.4	9.2
32	16,335	0.98	4.9	6.9	9.8
34	15,374	1.04	5.2	7.3	10.4
36	14,520	1.10	5.5	7.7	11.0
38	13,756	1.16	5.8	8.1	11.6
40	13,068	1.22	6.1	8.6	12.2

Calibration should be repeated whenever conditions (temperature, humidity, lot number of granules, etc.) change, when using a different chemical, driving a different speed, or changing your agitator speed.

Lesson 7

PESTICIDE APPLICATION EQUIPMENT

Answer the following questions True (T) or False (F).

____ 1) The most common type of pesticide applicator is a spray

____ 2) Hydraulic sprayers use water pressure to form droplets a

____ 3) The centrifugal pump is the best choice for high-pressure

____ 4) Brass nozzle tips should not be used to apply wettable too fast.

____ 5) Since an air-blast sprayer makes its own air stream, the o about the wind.

____ 6) Granular applicators distribute the material as formulated

____ 7) Pesticide application equipment doesn't need to be clea be applied at next application.

____ 8) Sprayer calibration is important only when the equipment

____ 9) The best way to make a calibration check is to actually some known area.

____10) Assume your sprayer has a 200-gallon tank and you ap much chemical do you add per tankfull to apply 3 pound
A. 30 pounds
B. 60 pounds

Circle correct answer.

11) The best sprayer to use for broadcasting a herbicide is the:
A) Air-blast sprayer
B) Hand-gun
C) Boomless sprayer (cluster of nozzles)
D) Boom sprayer
E) Duster

12) To minimize drift when applying a weed killer, the best type o
A) Flat fan
B) Flooding flat
C) Hollow cone
D) Solid cone
E) Makes no difference

13) The most important maintenance job is:
A) Cleaning
B) Lubrication
C) Painting
D) Draining
E) Storage

UIPMENT

or False (F).

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asting a herbicide is the:

zzles)

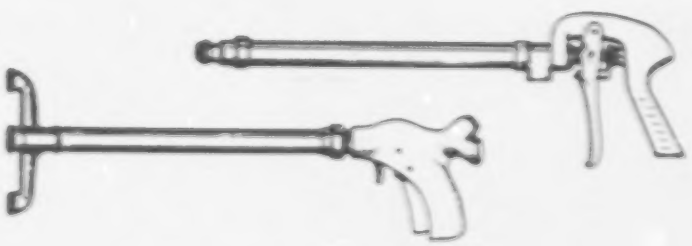
weed killer, the best type of nozzle tip to use is the

o is:

14) A farmer wants to calibrate his boom sprayer by the jar method. The nozzles on the boom are 20 inches apart so he measures the time to travel 204 feet and finds it to be 27 seconds. He determines that the average output per nozzle is 22 fluid ounces during a 27-second period. The application rate in gallons per acre is:
A) 20
B) 22
C) 27
D) 10
E) 7.5

15) A farmer wants to apply a granular insecticide in a band over the row for corn rootworm control. He wants to apply 7 pounds per acre on 36-inch rows. How much material should he collect on a 1,000-foot calibration check?
A) 11.0 oz.
B) 8.6 oz.
C) 20.8 oz.
D) .007 lb.
E) 7.7 oz.

Answers
1. T
2. T
3. F
4. T
5. F
6. T
7. F
8. F
9. T
10. A
11. D
12. B
13. A
14. B
15. E



Lesson 8

THE PESTICIDE LABEL

READ THE LABEL

Read the label!

These three words provide the key to the information about any pesticide you are planning to use. The label on the bottle, can, or package of a pesticide tells you the most important facts you must know about that particular pesticide for safe and effective use. The information on the label gives not only the directions on how to mix and apply the pesticide but also offers guidelines for safe handling, storage, and for protection of the environment.

Label information is the the result of years of research by scientists and both laboratory and field studies. The information on a pesticide label takes at least 5 to 7 years to obtain and can cost the chemical company producing the pesticide 5 to 6 million dollars. In the development and labeling of a pesticide, the scientists and others are interested in not only proving it is safe when used as directed but also if it controls pests; therefore, the label is important to you. It is your responsibility to *read and understand the label* before buying, using, storing, or disposing of a pesticide.

The background of a pesticide label

To appreciate the value of the information on the label, consider the time, effort, and money spent in gathering and documenting the label information.

Chemical companies all over the world continually make new compounds and then screen them in the laboratory and greenhouse for possible pesticide use. For each material that finally meets the standards of a potential pesticide, thousands of other compounds are screened and discarded for various reasons. When a promising pesticide is discovered, its potential use must be evaluated. If the company believes it has a worthwhile product and there is a possibility for reasonable sales volume, wide-scale testing and label registration procedures are begun. From this point of development until the pesticide reaches the market requires approximately 7 years — with costs in the millions of dollars.

Tests required before registering pesticides for use

Many kinds of carefully controlled tests must be made to determine the effectiveness and safety of each pesticide under a wide range of environmental conditions.

Toxicological or toxicity tests

How poisonous or dangerous is the pesticide to man, wildlife, and other organisms? To determine this, the material is administered by mouth (oral) and is applied to the skin (dermal) of rats, rabbits, or other animals. Vapors or gases are also checked to determine if they might harm the eyes or be inhaled by breathing. Extended feeding of test animals is also carried out to determine if the pesticide will cause cancer or affect the

offspring of the test animals.

Efficacy or performance tests

Does the pesticide control the pest? The company must have data to show that the pesticide will control a particular pest or a number of pests on one or more hosts and in so doing is valuable as a crop or animal protection tool. Data must show that the pesticide, when it is used for its intended purpose (according to direction), is a useful and necessary product.

Performance data must be collected for each pest and from each crop or animal species on which the material is to be used. Information on crop varieties, soil types, application methods and rates, and number of applications required are also needed. This information must prove that the pests are controlled, crops or animals are not injured, that yield and/or quality has been improved, and that the pesticide definitely provides a worthwhile benefit.

Degradation, mobility, and residue tests

What happens to the pesticide after it is applied? A series of studies is needed to show how long it takes for the compound to break down into harmless materials under various conditions (degradation). Does it move in the soil and ground water? Does it move into the plant from the soil (mobility)?

Residue studies are conducted on each method of application for each crop or animal to determine how much, if any, of the pesticide remains on the crop or animal. From these data, the number of days from the last pesticide application until harvest or slaughter are determined. Tolerance or the amount of a pesticide (residue) that may legally remain on or in food or feed is also established. The tolerance for a pesticide is set by the Environmental Protection Agency and is the amount that can safely remain on a food or feed commodity without hazard to the consumer. The tolerance may be set lower if the crop can be successfully produced with a lesser amount of residue remaining.

READ THE LABEL

A tolerance is set not only for each pesticide but also for each crop or commodity and is expressed in "parts per million" (PPM).

> For example, the tolerance for carbaryl (Sevin) on blackberries is 12.0 PPM; on blueberries, only 10.0 PPM.

All food or feed commodities must not be above the pesticide-residue-tolerance limit when ready for market or for farm feeding (this includes livestock, eggs, milk, etc.). If a residue is over the tolerance level, the commodity can be condemned and the producer penalized.

Effects on wildlife and environment

The chemical company must determine the effects of field application of the pesticide on wildlife, including fish. Results of

READ THE LABEL

these studies are usually summed up in the environmental impact statement for the pesticide.

The label review

The chemical company is now ready to take these data to the Pesticide Registration Division. Environmental Protection Agency, Washington, D. C.

The company asks for a registered use of the pesticide on as many pests, crops, and animals as they have test data to support their claims.

The request for label registration must now pass three reviews: 1) a review to determine the effectiveness of the pesticide for the purpose or purposes claimed; 2) a review by the Tolerance Section where the environmental, degradation, residue, and toxicological data are studied (this section sets the tolerance levels for the pesticide); and 3) a final review by the Pesticide Registration Division to determine if all claims on the label are supported by data.

If all goes well, a new pesticide will be registered for use and will soon be on the market.

Information on the label

Four labels from different pesticides are reproduced on pages 89-95. Take a few minutes and read them over. Although each is somewhat different, the basic information is much the same. The major items of information that appear on each of the labels are described. Did you understand this information when you read the labels the first time?

The brand name — common name — chemical name

The brand name is the producer's or formulator's proprietary or brand name for the pesticide. The common name is the generic name accepted for the active ingredient of the pesticide product, regardless of the brand name. The chemical name of the pesticide is the one that is long and difficult to pronounce unless you're a chemist. The names on the first label are: 1) Furadan, brand name; 2) carbofuran, common name; and 3) 2,3-dihydro-2,2dimethyl-7- benzofuranyl methylcarbamate, chemical name.

The ingredients in the container

The listing of ingredients tells you what and how much pesticide is in the container. They are listed as active and inert ingredients.

The active ingredient(s) gives the percentage or amount of chemical(s) that does the job that it is supposed to do.

On the first label, the active ingredient is carbofuran — 40.64 percent; there are 4 pounds of carbofuran per gallon.

The inert ingredients are the inactive materials that make up the rest of the contents. These may or may not be named. The inert ingredients may be diluents, solvents, emulsifiers, wetting agents, carriers, etc. The percentage of all these ingredients must be given.

The inert ingredients on the Furadan label total 59.36 percent and they are not named.

Uses of the pesticide

The label lists only the uses for which the pesticide is registered. These are the legal uses for the product. It should not be used for any other purpose or in any other manner not listed on the label. However, new uses for a pesticide product may be approved by the Environmental Protection Agency that may not appear on the label of a product packaged several months previously. If you have any doubt about a particular use not found on the label, check with your county agent or pesticide dealer.

Some products are registered for use only in specific areas or states. The use may or may not be legal for the area in which you live.

Imidan is registered for use on deciduous fruit trees as a dormant application with spray oil in the *Pacific States Only*.

Remember, the purpose for which you intend to use a particular pesticide must appear on the label when you buy the product.

Directions for using pesticides

Directions give you information you need on when to use the pesticide, how to apply the particular formulation, where to apply it, and dosage rates or how much to use. It also gives you one additional important bit of information — the number of applications that can be made over a given period of time and the length of time in days that you must allow between the last application and harvest or slaughter.

On many pesticide labels, you will find a range for the suggested dosage (see the Furadan label for directions on the control of the alfalfa weevil larvae). The range is ½ to 2 pints per acre. What dosage rate should you use in this case? Use the lowest rate you can that will give you the control needed. Contact your county agent for suggested rates that work well in your area.

Safety information, signal words, and precautions

Certain signal words are required on the label of pesticides. These words are *Danger-Poison* (in red) or *Warning* or *Caution*.

All pesticide labels must carry the statement — *Keep out of reach of children*. The signal word required depends upon the potential hazard or toxicity of the active ingredient and also upon the formulation.

The Furadan 4 Flowable label carries Danger-Poison, whereas a Furadan 10 percent Granules label carries the signal word, Warning, because the granular formulation is less hazardous than the concentrated flowable formulation.

For a review on what these signal words mean, see Lesson 6.

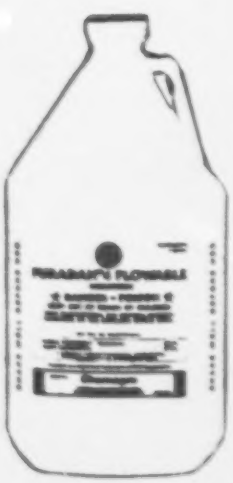
The four sample labels are for different pesticides and different formulations, and all have signal words.

It is these signal words and other cautions on the label that you must understand in order to use the product safely. Consider all pesticides as hazards and always work with them with this in mind. *Don't get careless!* Always check the label for "first aid treatments," and "antidotes for poisoning" and "note for the physician." The pesticide label is the most important information your physician can get from you in case of poisoning. The label also states how best to safely dispose of waste and used containers.

Other label information

Net contents or net weight appears on the label. This is given in pints, quarts, gallons, pounds, or similar units. The label bears the Environmental Protection Agency's registration number (EPA Reg. No. 279-2876 AA). This indicates the pesticide has passed the agency's review of the data and the product is ready for use according to the label's directions. The chemical company that made the product, or the formulator, or the company offering the product for sale will have its name and address on the label.

Now, once more, look at each of the sample labels.



The Furadan Label

1) The brand name is Furadan, the common name is carbofuran, and it is an insecticide. It contains 4 pounds of active ingredient per gallon and is a flowable formulation.

2) It is highly hazardous as indicated by the signal words, *Danger-Poison*.

3) It is for mixing with water for spraying to control weevil larvae on alfalfa. It can be applied only once during the season and a time interval between application and harvest must be observed.

4) First aid treatment: if *swallowed, induce vomiting;* if *inhaled, remain quiet, call a physician; on the skin, remove contaminated clothing and wash with soap and water*. The antidote for poisoning is atropine. Wear a mask or respirator while using

this product.

5) Toxic to fish, birds, and other wildlife.

The Eptam Label

1) The brand name is Eptam. The common name, EPTC, is not given on this label. It is a herbicide. It contains 10 pounds of active ingredient in each 100 pounds.

2) It has a low toxicity level; thus the signal word, *Caution*.

3) It is a granular formulation to be applied as is with equipment designed for application of granular pesticides. It is to be applied only to well worked soil and then incorporated into the soil immediately after application.

4) It is registered to control a wide list of annual grasses, annual broadleaf weeds, and perennial weeds. It will not control established weeds.

5) It is registered for use on numerous field crops and nursery stock.

6) Use precautions are listed. Bury waste and empty bags.

The Malathion Label

1) The brand name is Cythion, the common name is malathion, and it is an insecticide. It contains 5 pounds of active ingredient per gallon.

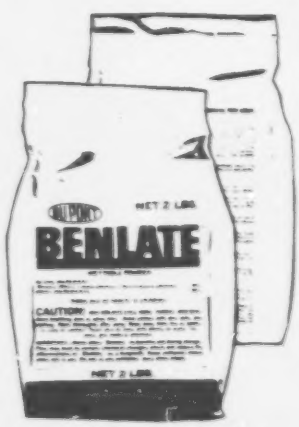
2) It has a low toxicity level, thus the signal word, *Caution*.

3) It is a liquid formulation to be mixed with water for spray application. It is registered for use against numerous insect pests on fruits, vegetables, field crops, and ornamentals. Can also be used on livestock and in buildings for fly and mosquito control.

4) Antidotes are atropine and 2-PAM.

5) Toxic to fish.

The Benlate Label



1) The brand name is Benlate, the common name is benomyl, and it is a fungicide. It contains 50 percent active ingredients.

2) It has a low toxicity level; thus the signal word, *Caution*.

3) It is a powder formulation to be mixed with water for spray application. It is registered for use against certain diseases that attack peanuts, sugar beets, snap beans, pineapple, sugarcane, roses, flowers, and ornamentals.

4) First aid treatment is flushing skin or eyes with plenty of water. Get medical attention for the eyes.

5) Do not contaminate water. Burn bag when empty.

You have just read the four labels for the second time and probably have a good idea of the information they contain. However, don't rely on your memory of what appears on the label. There are at least seven critical times when you should refer to the label when using a pesticide:

1) When you buy the product. You must know if this is the best product available for the job you want to do. Can you safely use it on YOUR crops or animals (under your conditions)? Do you have the proper equipment to apply the chemical properly? Do you know the active ingredients so you can purchase the proper amount to do the job?

2) Before you open the container to use the pesticide. You must know what protective devices are needed to safely handle the material. What are the mixing directions and the dosage rates? What are the first aid measures in case of an accident?

3) Before you apply the pesticide. You must double-check to be certain the pest to be controlled and the crop or animals to be treated are indicated on the label. What, if any, protective clothing is needed by the applicator? What are the methods and rates of application? Finally, what is the waiting period from application to harvest?

4) When you are not sure about a specific direction or precaution. Don't take chances and make mistakes. Check the label.

5) Before you store the pesticide. Pesticides should be stored where children and animals cannot reach them. They should be in a secure place where they can be locked up. What are the maximum and minimum temperatures at which they can be stored? And what other materials should not be stored with the pesticide?

6) Before you dispose of empty containers and waste material. You must know how to clean application equipment and how and where to dispose of empty containers and excess or waste materials.

7) Before you remove any pesticide from storage. Read the label to be certain this is the pesticide you want to use. If you're sure, re-read the label again. Double check steps 3, 4, 5, and 6.

A tremendous amount of time, effort, and money has been spent in obtaining label information. It is to your benefit to use this information wisely. By not following the label directions, you are guilty of misuse. The consequences of misuse or careless use could result in injury to you or others, to your livestock, or wildlife, or to your crops. It may mean poor or no control of the pest, and you will be liable for legal action for misusing a pesticide.

General-Use and Restricted-Use Pesticides

The Environmental Protection Agency will classify all pesticides into general use or restricted-use categories. Some pesticides may have uses in both categories. When this is so, the label will clearly distinguish between the directions relating to its general use from those relating to its restricted uses. In all cases, the pesticide label will indicate if the pesticide is for general or restricted uses.

General-use pesticides are those with moderately low toxicity and are of little potential hazard to humans and the environment when used properly. They can be purchased and used by the general public without certification, permit, or restriction.

Restricted-use pesticides may be sold only to a certified applicator and must be used by or under the supervision of a certified applicator. Pesticides in the restricted-use category can be potentially hazardous even when used according to directions. Therefore, applicators must understand their potential dangers and know how to use them properly.

CODE
2837

NET CONTENTS
1 GALLON

FURADAN® 4 FLOWABLE

INSECTICIDE

DIRECTIONS FOR USE

ALFALFA: Alfalfa Weevil Larvae, Egyptian Alfalfa Weevil Larvae, Pea Aphid, and in N. Y. State for Snout Beetle control — Apply the amount of Furadan 4 Flowable, indicated in the chart, when feeding is noticed or when insects appear. Alfalfa Weevil Adult — Apply 1 to 2 pints per acre when insects appear. Lygus Bugs — Apply 2 pints per acre prior to bloom.

Observe the indicated number of days after application before cutting or grazing. Do not apply more than once per season. Apply only to fields planted to pure stands of alfalfa.

Pints of FURADAN 4 Flowable Per Acre	Do not cut or graze within:
½	7 days
1	14 days
2	28 days

Minimum gallonage requirements: Ten gallons of finished spray per acre with ground equipment, two gallons per acre with aircraft.

FIELD CORN: Corn Rootworms—Use 1½ to 2 pints of Furadan 4 Flowable per 13,000 linear feet (1 acre with 40 inch spacing). Apply, at planting, as a 7 inch band over the row or inject on each side of the row by mixing with water or liquid fertilizers. When Furadan 4 Flowable is used with liquid fertilizers, mix in the following way making certain that the mixture is physically compatible: Premix 1 part of Furadan 4 Flowable with 2 parts of water. Add this premix to the tank of fertilizer along with rinsings from the premixing container. Maintain agitation in the tank after mixing and during application. Do not mix until ready to use.

SUGARCANE: Sugarcane borer—Apply 1 to 1½ pints Furadan 4 Flowable per acre using ground or aerial equipment. Check sugarcane fields weekly, beginning in early June and continuing through August. Make first application only after visible joints form and 5% or more of the plants are infested with young larvae feeding in or under the leaf sheath and which have not bored into the stalks. Repeat whenever field checks indicate the infestation exceeds 5 percent. Do not apply within 17 days of harvest. Do not use in Hawaii.

MANUFACTURED IN U.S.A. BY
FMC CORPORATION
AGRICULTURAL CHEMICAL DIVISION
MIDDLEPORT, N. Y. 14105

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DANGER-POISON

KEEP OUT OF REACH OF CHILDREN

READ ENVIRONMENTAL AND DISPOSAL CAUTIONS ELSEWHERE ON THIS CONTAINER BEFORE USING.

EPA REG. NO. 279-2876AA

SPECIMEN LABEL

ACTIVE INGREDIENT:	
Carbofuran*	40.64%
INERT INGREDIENTS:	59.36%
	100.0%

*2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
This product contains 4 lbs. of carbofuran per gallon.

Furadan is a registered trademark of FMC Corporation

SHAKE WELL BEFORE USE.

ENVIRONMENTAL AND DISPOSAL CAUTIONS

NOT FOR USE OR STORAGE IN OR AROUND THE HOME

ENVIRONMENTAL CAUTIONS:

This product is toxic to fish, birds and other wildlife. Birds feeding on treated areas may be killed. Keep out of any body of water. Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from areas treated. Do not contaminate water by cleaning of equipment, or disposal of wastes. Apply this product only as specified on this label. Do not move bees into Alfalfa fields within 7 days of application.

DISPOSAL WARNING:

Do not reuse this container. Completely empty the contents and bury the unused chemical at least 18 inches deep in an isolated location away from water supplies. Bury the container in the same manner.

DANGER

Poisonous by swallowing or inhalation. Do not breathe spray mist. Do not get in eyes. For eyes, get medical attention; in the meantime, flush eyes with plenty of water for at least 15 minutes. Avoid contact with skin. Wear a mask or respirator of a type passed by the U. S. Bureau of Mines for Furadan protection. For Emergency Assistance Call 716-735-3765.

FIRST AID

If swallowed, induce vomiting by giving a tablespoonful of salt in a glass of warm water. Repeat until vomitus is clear. Call a physician immediately.

If inhaled, remove to fresh air. Call a physician immediately.

If on skin. In case of contact, remove contaminated clothing and immediately wash skin with soap and water.

ANTIDOTE

To Physician: Furadan is a reversible cholinesterase inhibitor. Do not use oximes such as 2-PAM. Give atropine 2 mg. intravenously or subcutaneously. If in eye instill one drop of Homatropine.

Dealers Should Sell in Original Packages Only.

TERMS OF SALE OR USE: On purchase or use of this product buyer and user agree to the following conditions:

WARRANTY: FMC warrants that this product, as of the time of sale by FMC, (1) conforms to the ingredient statement on the label, and (2) is reasonably fit for the purpose set forth in the Directions for Use. EXCEPT AS SO WARRANTED THE PRODUCT IS SOLD AS IS. FMC MAKES NO OTHER WARRANTY EXPRESS OR IMPLIED.

DAMAGES: Buyer's or user's exclusive remedy for damages for breach of warranty or negligence shall be limited to direct damages not exceeding the purchase price paid and shall not include incidental or consequential damages. Notice of any claim must be reported to FMC within 10 days of discovery by buyer or user, failing which buyer or user waives any claim for such damage.

EXCUSE FROM NON-CONTROLLABLE CONDITIONS: Because of certain urtical conditions created or incurred by buyer or user or over which FMC has no control, buyer and user, as a condition of purchase or use, assume responsibility for and release FMC from, liability arising out of the handling or use of the product attributable to such causes. No person is authorized to vary or waive any statement contained herein.

FMC Chemicals

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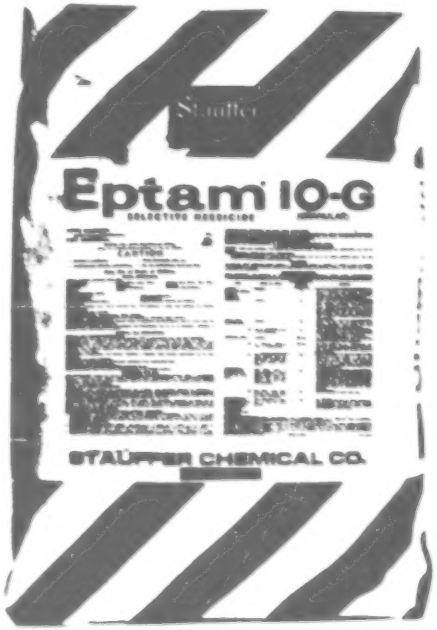


(Granular)

Eptam herbicide 10-G is a free-flowing granular which is highly effective and economical for control of many annual grasses and broadleaf weeds, along with nutgrass, quackgrass and Bermudagrass. Eptam 10-G is ideal for use in dry and snap beans, potatoes, alfalfa and certain ornamental plants. Eptam 10-G is biodegradable, and disappears from the soil after the weed-control work is done, leaving no harmful residues.

Controls Weeds in*

Alfalfa
Birdsfoot Trefoil
Clovers
Lespedeza
Beans, dry
Beans, snap
(pole and bush)
Potatoes, Irish
Ornamentals
Sugar Beets

(Most labeled applications)

*Consult label for additional crop uses.

Annual Grasses from Seed

Annual Bluegrass and Ryegrass, Crabgrass, Foxtails (giant, green, yellow), Goosegrass, Wild Oats, Lovegrass (Stinkgrass), Sandbur, Signalgrass (Brachiaria), Shattercane (Wild Cane), Volunteer Grain (Barley, Oats, Wheat), Watergrass (Barnyardgrass).

Annual Broadleaf Weeds

Annual morningglory, Black Nightshade, Chickweed, Corn Spurry, Deadnettle (Henbit), Hairy Nightshade, Lambsquarters, Purslane (Pusley), Nettleleaf Goosefoot, Pigweed (Redroot, Prostrate and Tumbling).

Perennial Weeds

Johnsongrass (from seed only), Quackgrass, Bermudagrass, Nutgrass (Nutsedge—purple and yellow).

Package Size

50-pound bag

NOTICE: Stauffer Chemical Company makes no warranty, express or implied, including the warranties of merchantability and/or fitness for any particular purpose concerning this material, except those which are contained on the Stauffer label attached to the product container.

A specimen label for this product is printed on the reverse side of this sheet. However, since actual labels are subject to revision, the label on the actual product container should always be carefully read and followed.

Printed in U.S.A. A-1033h Obsolete 5-74

Stauffer

Eptam® 10-G

GRANULES—A SELECTIVE HERBICIDE

Active Ingredient:	
S-ethyl dipropylthiocarbamate	10%
Inert Ingredients:	90%
(Contains 10 lbs. Active Ingredient per 100 lbs.)	U. S. Pat. No. 2,913,327

CAUTION — **Keep Out of Reach of Children**

HARMFUL IF SWALLOWED
AVOID CONTACT WITH SKIN AND CLOTHING.
AVOID BREATHING DUST.
WASH THOROUGHLY AFTER USING.
AVOID CONTAMINATION OF FEED AND FOOD.

WEEDS CONTROLLED

EPTAM will not control established weeds.

ANNUAL GRASSES:
Annual Bluegrass, (*Poa annua*)
Annual Ryegrass (Italian Ryegrass) (*Lolium multiflorum*)
Barnyardgrass (Watergrass, Junglerice) (*Echinochloa* spp.)
Crabgrass (*Digitaria* spp.)
Field Sandbur (*Cenchrus pauciflorus*)
Giant Foxtail (*Setaria faberi*)
Goosegrass (*Eleusine indica*)
Green Foxtail (*Setaria viridis*)
Johnsongrass seedlings (*Sorghum halepense*)
Wildcane (Shattercane, Black Ambercane, Chickencorn, Scattercane) (*Sorghum bicolor*)
Volunteer Grains (Barley, Oats, Wheat)
Wild Oats (*Avena fatua*)
Yellow Foxtail (*Setaria glauca*)

ANNUAL BROADLEAF WEEDS:
Black Nightshade (*Solanum nigrum*)
Common Chickweed (*Stellaria media*)
Common Lambsquarters (*Chenopodium Album*)
Corn Spurry (*Spergula arvensis*)
Deadnettle (Henbit) (*Lamium amplexicaule*)
Florida Purslane (*Richardia scabra*)
Hairy Nightshade (*Solanum villosum*)
Nettleleaf Goosefoot (*Chenopodium murale*)
Common Purslane (*Portulaca oleracea*)
Prostrate Pigweed (*Amaranthus graecizans*)
Redroot Pigweed (Common Pigweed) (*Amaranthus retroflexus*)
Tumble Pigweed (*Amaranthus albus*)

The annual broadleaf weeds listed above will be controlled only if treatment is made when conditions are favorable for weed germination and growth.

PERENNIAL WEEDS:
Bermudagrass (*Cynodon dactylon*)
Purple Nutsedge (Nutgrass) (*Cyperus rotundus*)
Quackgrass (Couchgrass, Witchgrass) (*Agropyron repens*)
Yellow Nutsedge (Nutgrass) (*Cyperus esculentus*)

Perennial weeds must be turned under and chopped up thoroughly prior to treatment. The underground rhizomes of quackgrass and the rhizomes and stolons of bermudagrass must be cut up thoroughly so that four or less nodes remain on a strand. For the control of quackgrass, bermudagrass the disc must be set to cut 6 inches deep and the higher rates of EPTAM must be used. Consult recommendations for crops on which the higher rates may be used.

USE PRECAUTIONS

- **READ ALL LABEL DIRECTIONS BEFORE USING.**
- EPTAM should be used only for recommended purposes and at recommended rates (DO NOT OVERDOSE).
- Applied according to directions and under normal growing conditions, EPTAM will not harm the treated crop. However, during germination and early growth, extended periods of unusually cold and wet or hot and dry weather, insect, nematode, or plant disease attack, carry-over pesticide residues, the use of certain soil applied systemic insecticides, highly saline or alkaline soil conditions, improperly placed fertilizers or soil insecticides may negate abnormal conditions that weaken crop seedlings. Used under these abnormal conditions, EPTAM could result in crop injury.
- Use equipment which has proven to incorporate thoroughly to the recommended depth.
- Do not contaminate water to be used on susceptible crops or for domestic purposes.
- EPTAM is recommended for use on mineral soils only.
- When applied according to directions and under conditions for normal crop growth, no harmful residues should remain beyond harvest.
- Do not apply prior to pre-irrigation.
- Keep container closed when not in use. Do not store near seeds or fertilizers.

NOTICE: Stauffer Chemical Company makes no warranty, express or implied, including the warranties of merchantability and/or fitness for any particular purpose concerning this material except those which are contained on Stauffer's label.

EPA Reg. No. 476-1620

1-ARC 720707-O

Made In U.S.A. By
Stauffer Chemical Company, Westport, Ct. 06880

BURY WASTE AND EMPTY CONTAINER IN A SAFE PLACE **50 LBS. NET**

DIRECTIONS FOR USE OF EPTAM

EPTAM is a selective herbicide which is mixed (incorporated) into the soil for control of weeds listed on this label. EPTAM controls weeds as their seeds germinate by interfering with normal germination and seedling development. It does not control established weeds.

APPLICATION DIRECTIONS

Apply only to well-worked soil that is dry enough to permit thorough mixing with incorporation equipment. Uniformly apply the recommended rate using equipment designed for application of granular herbicides. Equipment should be carefully calibrated before use and checked frequently during application to be sure it is working properly and delivering a uniform distribution pattern. Avoid overlaps that will increase EPTAM dosage above recommended rates as plant injury may occur.

INCORPORATION DIRECTIONS

EPTAM must be incorporated into the soil immediately to prevent loss of the herbicide. Whenever possible, application and incorporation should be done in the same operation.

SOIL MIXING (INCORPORATION) BEFORE PLANTING: Use power-driven cultivation equipment set to cut to a depth of 2 to 3 inches **OR** tandem disc set to cut to a depth of 4 to 6 inches, operated at 4 to 6 mph, followed by a spike-tooth harrow or some other leveling device which extends beyond the ends of the disc. For more thorough mixing (for perennial grasses and in heavier soils) disc in two different directions (cross disc).

INCORPORATION AT OR AFTER PLANTING: Use power-driven cultivation equipment set to cut to a depth of 2 to 3 inches or, on light soils only, ground-driven tillers (rolling cultivators, rotary hoe, row wheels, etc.) set to cut to a depth of 1½ inches and operated at 6 to 8 mph. When using ground-driven tillers, precultivate if soil is crusted. When incorporating after planting, care must be taken not to disturb the crop seed or seedling.

PLANTING DIRECTIONS

For pre-plant applications, seeding should be done as soon as possible after treatment to obtain a maximum period of weed control.

CULTURAL PRACTICES FOLLOWING APPLICATION

EPTAM is not persistent in the soil and susceptible weeds germinating later during the growing season may not be controlled. Shallow cultivation may be necessary to control these susceptible weeds that escape control by EPTAM as well as those weeds not susceptible to EPTAM. Do not cultivate deeper than the depth of the herbicide incorporation. Where tolerant broadleaf weeds are a problem, recommended post-emergence materials also may be applied.

RECOMMENDATIONS

These recommendations are given as broadcast (overall) rates of EPTAM 10•G per acre. For band treatment, use proportionately less material per acre depending on the width of band to be treated and the crop row spacing. Do not use band application on rocky ground because thorough incorporation is not possible.

ALFALFA, BIRDSFOOT TREFOIL, CLOVERS, LESPEDEZA: Temporary crop stunting and sealing of first leaves will occur if conditions for germination and crop growth are not good. Do not use EPTAM if a grass or grain nurse crop is to be planted with the legume.

National: For control of annual grasses and broadleaf weeds and nutsedge apply and incorporate 30 pounds of EPTAM 10•G just before planting.

Northern, Pacific Northwest and Western Regions Only: Apply 40 pounds EPTAM 10•G for quackgrass suppression (or control) and for control of nutsedge and annual broadleaf weeds and annual grasses in heavy soils. Do not exceed 30 pounds per acre in lighter soils.

BEANS, GREEN OR DRY: Do not use EPTAM on cowpeas (blackeye peas, blackeye beans), soybeans, Azuki beans, lima beans or other flat-podded beans except Romano. Under abnormal weather conditions, stunting may occur on Gratiot, Michilite, Sanilac and Seaway varieties. Do not exceed the 30 pound rate on small white beans, or on green beans grown on lighter soils.

Apply and incorporate EPTAM 10•G just before planting, immediately after planting or at the time of last cultivation. If applied before planting, rotary hoe during or shortly after emergence of the beans to break any crust which occurs. If applied at the time of last cultivation apply to the soil before bean pods start to form, and do not feed or pasture vines to livestock within 45 days after application.

National: Use 30 pounds EPTAM 10•G per acre for nutsedge, annual grass and broadleaf weed control.

IMPORTANT: The following recommendations are national or regional. National recommendations are for all regions. Regional recommendations are limited to the regions specified. Refer to the regional map below to determine your EPTAM 10•G region.

Northern and Pacific Northwest Regions Only: Use 40 pounds of EPTAM 10•G per acre for quackgrass suppression (or control) and for control of seedling Johnsongrass, nutsedge, annual broadleaf weeds and annual grasses in heavy soils.

CITRUS, NURSERY STOCK AND YOUNG FIELD PLANTINGS (NON-BEARING ORANGE AND GRAPEFRUIT GROVES)

National: After lining out, apply 30 to 60 pounds of EPTAM 10•G per acre to the soil and incorporate with cultivation equipment such as a tree hoe or rotary hoe.

CONIFER NURSERY STOCK (TWO-YEAR OLD LINING OUT STOCK OF AUSTRIAN PINE, EASTERN HEMLOCK, NORWAY PINE, RED PINE, SCOTCH PINE, WHITE PINE)

National: Apply and incorporate 30 pounds of EPTAM 10•G per acre just before planting or over well established plants. For control of quackgrass, heavy infestations of nutsedge, and annual broadleaf weeds apply and incorporate 60 pounds of EPTAM 10•G per acre.

CORN (FIELD, SILAGE AND SWEET): Corn is susceptible to injury from EPTAM. Do not use on milo or sorghum. Do not use on corn seed stock. Plant corn to a maximum depth of 2 inches.

Pacific Northwest Region Only: Pre-plant Incorporation: Apply and incorporate 20 pounds of EPTAM 10•G per acre just before planting.

Northern and Southeastern Regions Only: Preemergence incorporation: (For use only in areas where Johnsongrass seedlings and wildcane are problems). Plant corn. Apply 20-30 pounds EPTAM 10•G per acre over the planted crop. Use the higher rate if broadleaf weeds are a problem. Use rotary hoe type equipment to incorporate EPTAM into the soil to a maximum depth of 1½ inches.

FLAX

National: Apply and incorporate 30 pounds EPTAM 10•G per acre just before planting.

POTATOES, IRISH

- **Preplant**

  Southeast, Southwest, and Western Regions Only: Apply and incorporate 30 pounds EPTAM 10•G per acre.

  Northern and Pacific Northwest Regions Only: For annual grasses and broadleaf weeds use 30 to 60 pounds per acre. For quackgrass suppression (or control) and control of nutsedge, annual broadleaf weeds and annual grasses in heavy soils, use 40 to 60 pounds per acre.

OR

- **Drag-off (come up, weeding time):** The field must first be "dragged-off" followed by EPTAM application and incorporation. Use spike-tooth harrows or cultivation equipment for incorporation.

  National: For annual grasses and broadleaf weeds use 30 pounds per acre.

  Northern and Pacific Northwest Regions Only: For control of nutsedge, annual grasses and broadleaf weeds in heavy soils use 40 to 60 pounds EPTAM 10•G per acre.

- **Layby:** Apply after a clean cultivation. Apply when vines are dry and use cloth drag to knock granules off plant. Do not apply within 45 days of harvest.

  Southeast, Southwest, and Western Regions Only: Apply and incorporate 20 pounds EPTAM 10•G per acre.

  Northern and Pacific Northwest Regions Only: Apply to the soil and incorporate 30 to 40 pounds EPTAM 10•G per acre after the potato plants have emerged.

SAFFLOWER

National: Apply and incorporate 30 pounds EPTAM 10•G per acre just before planting.

SUGAR BEETS (POST-THINNING)

National: Apply and incorporate 30 pounds of EPTAM 10•G per acre after thinning and clean cultivation and incorporate to a depth of 2 to 3 inches.

TABLE BEETS

Pacific Northwest Region Only: Apply and incorporate 20 pounds EPTAM 10•G per acre just before planting. (Under normal use Table Beets are susceptible to injury and when EPTAM is used the seeding rate should be increased 10 percent.)

Stauffer

CYTHION® 5-E

PREMIUM GRADE MALATHION AGRICULTURAL INSECTICIDE EMULSIFIABLE LIQUID

ACTIVE INGREDIENTS:	
Malathion (O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate)	56.38%
Xylene Range Aromatic Hydrocarbon Solvent	35.50%
INERT INGREDIENTS:	8.12%
CONTAINS 5 LBS. PREMIUM GRADE MALATHION PER GAL.	

COMBUSTIBLE — Do not use or store near heat or open flame.

Rinse spray equipment and containers. Discharge liquid wastes in pit in non-crop lands located away from water supplies.

PERFORATE EMPTY METAL CONTAINERS. CRUSH & BURY GLASS.

CAUTION — Keep Out of Reach of Children

HARMFUL IF SWALLOWED OR INHALED. Avoid breathing vapor or spray mist. Avoid repeated or prolonged contact with skin. Wash thoroughly after handling. Wash contaminated clothing before re-use. Do not contaminate feed and feed.

NOTE TO PHYSICIANS: Malathion, upon repeated, prolonged and careless use, may cause cholinesterase inhibition. Atropine is antidotal. If symptoms warrant further treatment, Protopam Chloride (Pralidoxime Chloride, 2-PAM Chloride) has shown utility as adjunctive therapy.

SAMPLE

NOTICE: Stauffer Chemical Company makes no warranty, express or implied, including the warranties of merchantability and/or fitness for any particular purpose, concerning this material, except those which are contained on Stauffer's label.

Minimum Storage Temperature 8°F. Liquid phases separate at lower temperatures. Warm or store at higher temperatures, and mix thoroughly to recombine liquid phases and assure uniformity before use.

USDA Reg No 476-3022 (W WE 710329 SWI DA 710510NE

Lot No._____

1 GAL. NET

STAUFFER CHEMICAL COMPANY
NEW YORK, NY 10017

STRAWBERRIES: Aphids (use at rate 3⅓ pt.), field crickets, lygus bugs, potato leafhopper, spider mites, spittlebugs, strawberry leaf-roller, strawberry root weevil, thrips, whiteflies, 2-3 pt. (for strawberry root weevil control, make applications to the soil surface before planting and work into the top 6-8 inches). Do not apply within 3 days of harvest. (3⅓ pt.)

SWISS CHARD: Aphids, blister beetle, cucumber beetle, 3⅓ pt. Do not apply within 7 days of harvest. (3⅓ pt.)

TOMATOES: Aphids, spider mites, 2 pt. Drosophila flies, 3⅓ pt. in full coverage application to fruit and foliage. Do not apply within 1 day of harvest. At rates over 3⅓ pt. up to 5⅓ pt. do not apply within 5 days of harvest. California only: These higher rates may be applied up to 3 days of harvest. (5⅓ pt.)

PASTURE AND RANGE LAND: Aphids, grasshoppers, leafhoppers, 1½-2 pt. Or use 1½ pt. in 1 gal. diesel fuel oil by means of an airplane or a turbine-blower type sprayer. May be applied on day of harvest or grazing.

WASTELANDS, ROADSIDES, SOIL-BANK LANDS (Not Grazed): Grasshoppers, 1½-3 pt. or in 1 gal. diesel fuel oil by means of an airplane or a turbine-blower type sprayer.

STORAGE PEST PROTECTION

For Protection Against: Cereal Leaf Beetles, Confused Flour Beetle, Indian Meal Moth, Flat Grain Beetle, Granary Weevil, Lesser Grain Borer, Red Flour Beetle, Rice Weevil, Rusty Grain Beetle, Saw-toothed Grain Beetle.

GRAINS: BARLEY, CORN, GRAIN SORGHUM, SEEDS, OATS, RICE, RYE, WHEAT:

GRAINS — RESIDUAL SPRAY — BEFORE STORING: (For walls, floors and machinery in grain elevators, in treating truck beds, boxcars, and ships' holds before loading grain): Use 1 gal. per 25 gal. water. Make thorough application. Before applying spray, clean elevators, boxcars, truck beds, etc. thoroughly. Remove and burn all sweepings and debris.

GRAINS — GOING INTO STORAGE: Use 1 pt. in 2-5 gal. water per 1000 bu. Apply as grain is being loaded or turned into final storage.

GRAINS — AFTER STORED: To protect clean or uninfested grain from Indian Meal Moth, use ½ pt. in 1-2 gal. water per 1000 sq. ft. of grain surface area. Apply evenly over surface of grain. Apply immediately after grain is loaded into storage and repeat if necessary.

RESIDUAL SPRAY FOR BOXCARS FOR LOADING AND TRANSPORTING BAG FLOUR AND PACKAGED CEREALS: For control of the exposed stages of Confused Flour Beetle, Rice Weevil, Granary Weevil, Saw-toothed Grain Beetle, Flat Grain Beetle, Red Flour Beetle, Rusty Grain Beetle, Lesser Grain Borer, Indian Meal Moth and Mite pests infesting empty boxcars. Apply as follows: Clean the boxcar thoroughly, then remove and burn all sweepings and debris. Spray walls and floor to the point of run-off with either 1 gal. in 25 gal. of water, or 1 gal. in 19 gal. of deodorized kerosene. (The deodorized kerosene solution should be made up of 4 parts kerosene-type solvent plus 1 part aromatic hydrocarbon-type solvent.) Let the sprayed boxcar stand empty with the doors open until the spray has thoroughly dried. Line the walls and floor of the boxcar with kraft paper before loading.

FIELD AND GARDEN SEEDS

FIELD AND GARDEN SEEDS: Field and garden seeds can be protected against the listed grain pests with a dosage of ½ pt. in 1-2½ gal. of water per 500 bu. of seed. May be used under the requirements of the Khapra beetle quarantine, where water or diesel oil emulsions are indicated, as prescribed by the current quarantine instructions.

PEANUTS

PEANUTS — RESIDUAL SPRAY — BEFORE STORAGE: Clean warehouse thoroughly of trash and remains of old peanuts 1-2 weeks before new peanut crop is stored. Then, thoroughly spray the interior of the empty warehouse, especially cracks and protected places. Treat outside walls to a height of 6-8 ft. and the ground to a distance of 6 ft. from the warehouse. Use 1 pt. in sufficient water to make 2½ gal. of spray or 1 gal with 19 gal. of water. Apply as a coarse spray at the rate of 2 gal. per 1,000 sq. ft. of surface or to run-off.

PEANUTS — BULK SPRAY TREATMENT — GOING INTO STORAGE: Use 2½ pt. in 5 gal. of water for each 15 tons of farmers stock peanuts as they go into storage.

Use good spray equipment. Apply coarse spray uniformly. Preferably, use a suitable mechanical spray applicator that regulates the rate of application to the flow of peanuts. Adjust the operating pressure of spray pump and size of nozzle opening to correlate the amount of spray delivery with the rate of flow of peanuts being treated. Avoid spraying with a fine mist that drifts away, by using low nozzle pressure. Shield the nozzle against wind and air currents.

PEANUTS — SUPPLEMENTAL SURFACE SPRAY: After warehouse has been filled, level surface of peanuts before spraying. Apply surface spray using 1¾ lb. of Cythion 25% wettable powder in 2 gal. of water and apply at the rate of 2 gal. per 1,000 sq. ft. of surface. Apply first treatment as soon as bin is filled and leveled, but not later than the first week in Oct. Apply the second surface treatment 1 month later, followed by treatment at 2 month intervals. Use a piston-pump type power sprayer, equipped with an agitator, and with a nozzle capable of delivering a coarse spray. Use spray equipment with sufficient capacity and power to cover large surfaces thoroughly.

ORNAMENTALS

Dosages given are for use in 100 gal. of dilute spray.

Aphids, European pine shoot moth, four-lined leaf bug, Japanese Beetle adult, mealybugs, millipedes, potato leafhopper, rose leafhopper, scurfy scale, spider mites, springtails, sowbugs, tarnished plant bug, thrips, whitefly, euonymus scale, face scale, oyster shell scale	1½ pt.
Azalea scale, bagworms, birch leafminer, boxwood leafminer, Fletcher scale, Florida-red scale, juniper scale, magnolia scale, oak kermes, pine leaf scale, tent caterpillar	2 pt.
Black scale crawlers, Monterey pine scale	2-½ pt.
Pine needle scale, wax scale	4 pt.

For oyster shell, Fletcher, juniper, oak kermes and pine needle scales, apply when scale crawlers have settled on foliage.

CAUTION: Avoid use on certain ferns including Boston, Maidenhair and Pteris, as well as some species of Crassula and Casuarina Juniper.

POULTRY

POULTRY RANGES—Chiggers—Apply 1½ pt. Make full-coverage application 1 day prior to placing poultry on range. Repeat applications every 2-3 weeks as needed. Avoid contamination of feeding troughs and water-fountains.

ROOST PAINT—Chicken red mites, poultry lice—Mix 2-7 fl. oz. of this material per 1 gal. water or diesel fuel oil. Brush on this solution as a roost paint at the rate of 1 pt. per 150 ft. of roost.

FLY CONTROL

For use in and around buildings which house domestic animals, around homes, around yards and the outside of meat and food processing plants. Do not use in the edible product areas of meat and food processing plants.

SYNERGIZED CYTHION SPRAYS		CYTHION BAIT SPRAYS			
Amt. of Spray	Amt Cythion 5-E	Amt. of Bait Spray	Amt Cythion 5-E	Sugar (or)	Unsulfurized Molasses or Corn Syrup
2½ gal	1 cup	2½ gal	1 cup	1 cup	1 cup
12 gal	1 qt	12 gal	1 qt	2½ lb	1 qt.
100 gal	2 gal	100 gal	2 gal	20 lb	2 gal

Apply spray at rate of 1 gal. per 1,000 sq. ft. on painted surfaces and 2 gals. per 1,000 sq. ft. on unpainted surfaces where flies alight or congregate. In most cases, adding molasses or sugar to the spray prolongs the insecticidal activity and serves as a fly attractant.

CAUTION: Avoid contamination of milk, milk equipment and water. Avoid contamination of feed and food products; also drinking fountain and feed troughs. Remove calves under one month of age and lactating dairy animals from buildings before treating.

DROSOPHILA FLIES and DRIED FRUIT BEETLES: On or around cull fruit and vegetable dumps. Mix 1½ gal. in 100 gal. of water and apply as a drench, using 8-10 gal. of spray per 100 sq. ft. (for best results dumps should not be over 18" deep). Do not feed treated fruit and vegetables.

MOSQUITO CONTROL

MOSQUITOES, FLIES AND SMALL FLYING INSECTS: For use by trained personnel, as a 2-5% fog, aerosol or space spray. To make a 2% solution dilute in 1 to 28 parts of water, fuel oil or diesel oil. When using kerosene-type solvent as carrier, dilute 1 part in 28 parts of a mixture consisting of 4 parts kerosene-type solvent and 1 part aromatic hydrocarbon-type solvent. For a 5% solution, dilute 1 part in 11 parts of mixture using similar solvents.

MOSQUITO LARVAE IN STANDING WATER: Apply at the rate of 13 fl. oz. (approx. ⅜ pt.) per acre. Mix in sufficient water or oil to obtain even coverage when applied by air or ground. Repeat applications as necessary. Avoid applying oil-based formulations to valuable ornamental plants as injury may occur. May be toxic to certain species of fish, particularly in shallow water.

USE PRECAUTIONS (Read entire label before using.)

Highly toxic to fish. Do not contaminate any body of water, by direct application, cleaning of equipment or disposal of wastes and containers.

This product is highly toxic to bees exposed to direct treatment or residues on crops. Protective information may be obtained from your Cooperative Agricultural Extension Service.

In order that pesticidal residues on food and forage crops will not exceed tolerances established by the Federal Food and Drug Administration, use only at recommended rates and intervals, and do not apply closer to harvest than specified. Do not apply or allow to drift to areas occupied by unprotected humans or beneficial animals or onto adjoining seed, fiber or pasture crops. The grower is responsible for residues on his crops as well as for damages caused by drift from his property to that of others.

Consult state agricultural extension service or state agricultural experiment stations for additional information, as the timing, number, and rate of applications needed will vary with local conditions.

DIRECTIONS FOR USE

Pour specified amount of this product into nearly filled spray tank. Add balance of water to fill tank. Keep agitator running during filling and spraying operations. If mixture does not mix readily, but tends to separate as an oily layer, do not use as injury to plants may result. Do not combine with wettable powders unless previous use of the mixture has proven physically compatible and safe to plants. Always thoroughly emulsify this product with at least half of total water before adding wettable powder.

SUGGESTED WATER RATES FOR AIRCRAFT AND GROUND APPLICATION. (The actual rate required to provide thorough, uniform coverage varies with plant growth at time of application. Except as specified for certain uses, the following rates are therefore intended to cover a broad range of conditions.)

Crop	Gal. Water/Acre Aircraft	Ground
Vegetable and Field Crops	1-20	5- 125
	5-25	
Orchard, Grapes		300- 800
Orchard Crops (See exceptions below)		500-1000
Citrus		100- 200
Grapes		

RECOMMENDATIONS

Unless otherwise indicated, dosages are given in pt. of Cythion 5-E per acre in sufficient water to provide thorough coverage of vegetable and field crops and pt. of Cythion 5-E per 100 gal. water for thorough coverage sprays of tree fruit crops. Begin applications when insects first appear and repeat at 7-10 day intervals as needed to maintain control, but observe use limitation given for specific crops.

Maximum permissible rate per acre, expressed as Cythion 5-E, is given in parenthesis, ( ), after each crop claim.

CROP USES

TREE FRUIT CROPS

APRICOTS: Aphids, codling moth, European lecanium scale, orange tortrix, soft brown scale: 1¼-2 pt. Do not apply within 7 days of harvest. (10 pt.)

CHERRIES: Black cherry aphid, bud moth, cherry fruit fly, fruit tree leaf roller, lesser peach tree borer (apply to trunks and scaffold limbs at 21 day intervals beginning with emergence), Forbes and San Jose scales (apply 3 weeks before and immediately after harvest): 1-1¼ pt. Do not apply within 3 days of harvest. Caution: May cause injury on certain varieties of sweet cherries in the Northeast. (12½ pt.)

CITRUS: California red scale, yellow scale, purple scale, black scale (single and all-brooded) soft scale, thrips, citricola scale, orangeworm, aphids: 1½-1¾ pt. Do not apply within 7 days of harvest. Make no application when trees are in full bloom. California—Do not apply unless parasite activity on the scale is at a low level or absent. (40 pt.)

GRAPES: European fruit lecanium, grape leafhopper, mealybug, spider mites: 1¼ pt. Do not apply within 3 days of harvest. Injury may occur to Ribier, Cardinal and Almeria varieties when applications are made after the clusters appear (4½ pt.)

PEACHES: Black cherry aphids, black peach aphid, green peach aphid, Japanese beetle, rusty plum aphid: 1½ pt. Oriental fruit moth, plum curculio and scales (European fruit lecanium, terrapin, cottony peach): 2 pt. Do not apply within 7 days of harvest. (14½ pt.)

VEGETABLE AND FIELD CROPS

ALFALFA, CLOVER: Alfalfa weevil larvae, aphids, armyworms, clover leaf weevil, grasshoppers, lygus bugs, pea aphid, potato leafhoppers, spider mites, spittlebugs, vetch bruchid: 1½-2 pt. Use higher rate for armyworm control. May be applied on day of harvest or grazing. Do not apply during full bloom. (2½ pt.)

ASPARAGUS: Asparagus beetle, thrips: 2 pt. Do not apply within 1 day of harvest. (2 pt.)

BEANS: Aphids, cucumber beetle, Japanese beetle, Mexican bean beetle, orthezid beetle, pea leaf weevil, potato leafhopper, spider mites: 2½ pt. Lygus bugs (on dry beans in California)—1½-2 pt. Do not apply within 1 day of harvest. (2½ pt.)

BEETS, GARDEN (Seed Crop): Lygus: 2 pt. Apply in seedball to hard seed stage. Repeat as needed. (No limitation.)

BEETS, TABLE: Aphids, beet armyworm, blister beetles, flea beetle: 4 pt. Do not apply within 7 days of harvest. (4 pt.)

BEETS, SUGAR: Aphids, spider mites: 2 pt. Do not apply within 7 days of harvest if tops are to be used as food or feed. (4 pt.)

BERRIES (blackberry, blueberry, boysenberry, dewberry, loganberry, raspberry): Aphids, Japanese beetle, rose leafhopper, rose scale, two-spotted spider mites, sap beetle: 3 pt. Do not apply within 1 day of harvest. (blueberries 4 pt.; raspberries 7½ pt.; others 6½ pt.)

CARROTS, PARSNIPS, RADISHES, SALSIFY, HORSERADISH: Aphids, diamond back moth, flea beetle, leafhoppers: 3 pt. Do not apply within 7 days of harvest. (horseradish 4 pt.; others 3½ pt.)

CELERY: Aphids, leafhoppers, spider mites, white flies: 2 pt. Do not apply within 7 days of harvest. (2½ pt.)

COLE CROPS (broccoli, Brussels sprouts, cabbage, kale, mustard, turnips): Aphids, cabbage loopers, flea beetles, imported cabbage worm: 2-3 pt. Use higher rate for loopers and worms. Do not apply within 3 days of harvest on broccoli and turnips; 7 days on others: (turnips 4½ pt.; others 4 pt.)

CORN: Aphids, corn rootworm adults, sap beetles, thrips, young grasshoppers: 1½ pt. Do not apply within 5 days of harvest or forage use. Caution: Injury may occur in the whorl and silk stages with emulsifiable liquids. (1½ pt.)

COTTON: Aphids, brown cotton leafworm, cotton leaf perforator, leafhoppers, spider mites, whiteflies: ½-2 pt. Cotton fleahoppers: 1-1½ pt. Fall armyworms, boll weevils, grasshoppers, garden webworms and lygus: 1½-2 pt. (6½ pt.)

CRANBERRIES: Black-headed fireworm, cranberry fruitworm, leafhoppers, spittlebug nymphs: 1½ pt. Do not apply within 3 days of harvest. (4 pt.)

CUCUMBER, PUMPKIN, SQUASH: Aphids, cucumber beetle, cutworms, darkling ground beetles, leafhoppers, pickleworm, spider mites, squash vine borer, thrips: 2½ pt. Do not apply within 3 days of harvest on pumpkins. Do not apply on cucumber and squash unless plants are dry or within 1 day of harvest (pumpkin 3½ pt.; others 2½ pt.)

EGGPLANT: Aphids, lace bug, spider mites: 2-3 pt. Use higher rate for lace bugs. Do not apply within 3 days of harvest. (5½ pt.)

GRASS AND CEREAL CROPS (Barley, corn, oats, wheat, bare grass, canary grass, fescue, orchard grass, red top, timothy and yellow foxtail): Cereal leaf beetle: 1-1½ pt. Do not apply within 7 days of harvest or forage use on barley, oats and wheat. 5 days on corn. Grass, Grass hay pastures and Range land. Aphids, leafhoppers: 1½-2 pt. Repeat application as necessary (Grasses 2 pt.; corn 1½ pt.; other cereals 2 pt.)

HOPS: Aphids, mites, 1 pt. Do not apply within 7 days of harvest. (2 pt.)

LETTUCE, ENDIVE: Aphids, alfalfa looper, cabbage looper, leafhoppers, mites, 3 pt. Do not apply within 14 days of harvest on leaf lettuce, 7 days on endive and head lettuce. (3½ pt.)

MINT: Aphids, flea beetle adults, spider mites: 1½ pt. Do not apply within 7 days of cutting. (1½ pt.)

ONIONS: Onion maggot, thrips: 3½ pt. For onion maggot control apply when flies first appear and repeat every 4 days. Do not apply within 3 days of harvest on green onions. (3½ pt.)

PEAS: Aphids, pea weevil: 2 pt. Do not apply within 3 days of harvest; 7 days if pea vine hay is to be fed to livestock. (4 pt.)

PEPPERS: Aphids, pepper maggot: 2½ pt. Do not apply within 3 days of harvest. (2½ pt.)

POTATOES: False chinch bugs, leafhoppers, mealybugs: 1½ pt. Aphids, blister beetles: 4 pt. (4½ pt.)

RICE: Leafminers: 2½ pt. Make first application when first rice blades appear on surface of the water and repeat as necessary. Stink bugs: 1½ pt. in a minimum of 2 gal. water applied by aircraft during the early milk and dough stage of growing rice. Do not apply within 7 days of harvest. (2½ pt.)

SAFFLOWER: Aphids, lygus bugs, grasshoppers: 1½-2 pt. Do not apply within 3 days of harvest. (2 pt.)

SMALL GRAINS (Barley, oats, rye, wheat): Armyworms, English grain aphids, grasshoppers, greenbugs: 1½-2 pt. Do not apply within 7 days of harvest. (2 pt.)

SPINACH: Aphids: 2½ pt. Do not apply within 7 days of harvest. (3½ pt.)

Continued on Right Panel

Stauffer Chemical Company
New York, N. Y. 10017

SPECIMEN LABEL

DU PONT

BENLATE®

BENOMYL FUNGICIDE

Wettable Powder

ACTIVE INGREDIENT	
Benomyl [Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate]	50%
INERT INGREDIENTS	50%

Keep out of reach of children.

CAUTION! MAY IRRITATE EYES, NOSE, THROAT, AND SKIN.
Avoid breathing dust or spray mist. Avoid contact with skin, eyes, and clothing. Wash thoroughly after using. Keep away from fire or sparks.
In case of contact, flush skin or eyes with plenty of water; for eyes, get medical attention.

IMPORTANT—Never allow "Benlate" to become wet during storage. This may lead to certain chemical changes which will reduce the effectiveness of "Benlate" as a fungicide. Keep container closed when not in use. This product is toxic to fish. Keep out of lakes, streams, or ponds. Do not apply when weather conditions favor drift from areas treated. Do not contaminate water by cleaning of equipment or disposal of wastes.

Do not re-use bag; burn when empty.

NET 2 LBS.

E. I. du Pont de Nemours & Co. (Inc.)
Biochemicals Department, Wilmington, Delaware

DIRECTIONS

Du Pont "Benlate" Benomyl Fungicide should be used only in accordance with recommendations on this label, or in separate published Du Pont recommendations available through local dealers.

Du Pont "Benlate" Benomyl Fungicide is recommended for the control of many important plant diseases. As a foliar treatment, it provides systemic, curative (eradicant), and protective action. If treatment is not effective following use of "Benlate" as recommended, a tolerant strain of fungi may be present (contact your Du Pont representative); consideration should be given to prompt use of other suitable fungicides.

Apply as a spray (except as otherwise directed), using sufficient water to obtain thorough coverage of the plants. For aerial application (peanuts and sugar beets only), use 5 to 10 gals. per acre. Under severe disease conditions, use the higher rate and shorter interval specified for each crop; also, for tree crops, use the higher rate for large mature trees.

Add required amount of "Benlate" to a partially filled spray tank agitated by hydraulic or mechanical means; continuous agitation is required to keep the material in suspension. Do not use alkaline pesticides, such as basic copper sulfate, Bordeaux mixture, or lime sulfur, as a tank mixture with "Benlate".

ALMONDS: Brown Rot Blossom Blight—Apply 1 to 1½ lbs. per acre at pink bud. Under severe disease conditions and on highly susceptible varieties, make a second application during half-to-full bloom.

APPLES, PEARS: Apply 200 to 500 gals. of spray per acre with hydraulic ground equipment or equivalent amount of "Benlate" per acre with concentrate sprayers. Do not graze livestock in treated orchards.

Scab (Apples), Powdery Mildew, Sooty Blotch, Flyspeck—Use 4 to 6 oz. per 100 gals. at ½" green tip and repeat at 7- to 14-day intervals (or as needed) through the cover sprays. If an application is missed and an infection period has occurred, apply 6 oz. per 100 gals. as soon as possible after the infection period in order to deactivate scab and to prevent further infection. With Golden Delicious, Rome, and Stayman varieties of apples, adverse effects on fruit finish and color may result; if finish and color are of primary importance, do not use more than 4 oz. per 100 gals.

Postharvest Fruit Rots (Botrytis sp., Penicillium sp., Gloeosporium sp.)—Make a single application of 6 oz. per 100 gals. 1 to 3 weeks before harvest. For additional protection of fruit to be held in storage, thoroughly wet harvested fruit by dipping or spraying at 6 oz. per 100 gals.

Overwintering Scab (Apples)—Apply 8 oz. per 100 gals. after harvest but before leaf drop. Thorough wetting of foliage is necessary.

BEANS (SNAP): White Rot (Sclerotinia), Gray Mold (Botrytis)—Apply 1½ to 2 lbs. per acre at 25% to 50% bloom; repeat at peak bloom. Do not apply within 14 days of harvest; do not graze or feed treated bean vines or hay to livestock.

CUCURBITS—CUCUMBERS, MELONS, SUMMER AND WINTER SQUASH: Gummy Stem Blight, Powdery Mildew, Anthracnose—Apply 4 to 8 oz. per acre. Begin applications when plants begin to run or when disease first appears, and repeat at 7- to 14-day intervals as needed.

MACADAMIA NUTS (HAWAII): Botrytis Blossom Blight—Apply 1¾ lbs. per acre; a surfactant may be added to the spray to improve wetting of foliage. Begin applications 1 to 2 weeks prior to bloom, and repeat at 7- to 14-day intervals through the bloom period.

CONTINUED ON SIDE PANEL ▶

4/73

Printed in U.S.A.

DIRECTIONS—CONTINUED FROM BACK PANEL

MANGOES: Anthracnose—Apply 1 to 2 lbs. per acre. Begin applications at first appearance of panicles (approx. 2" long), and repeat at weekly intervals until all fruits are set. Continue at 3- to 4-week intervals. Do not apply within 14 days of harvest.

MUSHROOMS: Verticillium Spot (Dry Bubble)—Use 1 lb. per 100 gals. and apply to bed surface at the rate of 12½ gals. per 1000 sq. ft. Apply immediately after casing and repeat at pinning; alternatively, if disease has occurred, apply to beds after picking and repeat 10 days later. Do not apply within 2 days of harvest.

PEANUTS: Cercospora Leafspot—Apply 6 to 8 oz. per acre. Begin application 35 to 40 days after planting or when disease first appears, and repeat at 14- to 21-day intervals as needed. Do not apply within 14 days of harvest.

PECANS: Pecan Scab, Brown Leafspot, Downy Spot, Powdery Mildew—Apply ½ to 1 lb. per acre; use the higher rate for trees over 30 ft. tall. A surfactant may be added to the spray to improve wetting of foliage. Apply at prepollination when young leaves are unfolding, when small nuts are forming, and thereafter at 3- to 4-week intervals. Do not apply after shucks split.

PINEAPPLE: Pineapple Butt Rot (Thielaviopsis paradoxa)—Use 1¼ lbs. per 100 gals. of water as preplant dip treatment. Immerse seedpieces to give thorough wetting; remove and allow to drain.

STONE FRUITS—APRICOTS, CHERRIES, NECTARINES, PEACHES, PLUMS, PRUNES: Apply 150 to 400 gals. of spray per acre with hydraulic ground equipment or equivalent amount of "Benlate" per acre with concentrate sprayers. Do not graze livestock in treated orchards.

Brown Rot Blossom Blight, Fruit Brown Rot—Use 1 lb. per 100 gals. (in combination with dormant oil) as a delayed dormant treatment prior to bud break. Use ½ lb. per 100 gals. at early bloom (popcorn, red bud, or green tip) and at full bloom; apply 1 or 2 additional sprays beginning 3 weeks before harvest.

For following diseases, use the same schedule as for Brown Rot plus additional applications of ½ lb. per 100 gals. as indicated: **Peach Scab**—shuck split and shuck fall; **Powdery Mildew**—shuck fall and first cover; **Cherry Leaf Spot**—2 to 3 weeks after harvest.

Postharvest Fruit Rots—Dip or spray fruit thoroughly as soon as possible after harvest; use ½ lb. per 100 gals. "Benlate" does not control fruit rots caused by **Rhizopus** spp. and **Alternaria** spp.

CONTINUED ON OPPOSITE SIDE PANEL

DIRECTIONS—CONTINUED FROM OPPOSITE SIDE PANEL

STRAWBERRIES: Gray Mold (Botrytis), Powdery Mildew, Leaf Scorch, Leaf Blight, Leaf Spot—Apply 1 lb. per acre at 10% bloom and at full bloom; continue at 10- to 14-day intervals, using ½ lb. per acre. **Anthracnose**—Apply 1 lb. per acre when plants are established (plant bed or field) and repeat at 7-day intervals.

SUGAR BEETS: Cercospora Leafspot—Apply 6 to 8 oz. per acre. Begin application when disease first appears and repeat at 14- to 21-day intervals as needed. Do not apply within 21 days of harvest.

SUGARCANE (HAWAII): Pineapple Disease (Ceratocystis paradoxa)—Apply to cut seedpieces either as a cold dip or hot dip.

Cold Dip—Use 8 oz. per 100 gals. of water (1:1600). Immerse seedpieces to give thorough wetting; remove and allow to drain.

Hot Dip—Use 4 oz. per 100 gals. of water (1:3200). Maintain temperature of the dip at 50°C. Soak seedpieces for 20 to 30 minutes; remove and allow to drain.

ROSES (Powdery Mildew, Black Spot); FLOWERS, ORNAMENTALS (Powdery Mildew, Botrytis Gray Mold): Field and Greenhouse—Use 8 oz. per 100 gals. of water (1 tablespoonful per 2 gals.). Apply when disease first appears and repeat at 10- to 14-day intervals throughout the growing season; shorten interval during humid, rainy weather. Addition of a surfactant to the spray mixture enhances curative action of the fungicide, and improves distribution of the spray on hard-to-wet plants such as roses.

BULBS (Easter Lily, Tulip, Gladiolus, Daffodil, Iris); Fusarium and **Penicillium Rots**—Use 1⅔ lbs. per 100 gals. of water (2 tablespoonsful per gal.). Soak cleaned bulbs for 15 to 30 minutes in warm dip (80 to 85°F.), preferably within 48 hours after digging. Dry bulbs after treatment. If bulbs are for forcing, treat after bulbs have been heat-cured.

NOTICE TO BUYER—Seller warrants that this product conforms to the chemical description on the label thereof and is reasonably fit for purposes stated on such label only when used in accordance with directions under normal use conditions. This warranty does not extend to use of this product contrary to label use directions, or under abnormal use conditions, or under conditions not reasonably foreseeable to seller; buyer assumes all risk of any such use. Seller makes no other warranties, express or implied.

Lesson 8

THE PESTICIDE LABEL

Answer the following questions True (T) or False (F).

____ 1) You should read the label before using any pesticide.

____ 2) The toxicity of a pesticide is determined only by its effect on an animal when it is ingested by mouth.

____ 3) Before a pesticide is registered for use, the manufacturer must supply EPA with supporting performance data showing that it is a useful and necessary product and provides a worthwhile benefit.

____ 4) Hazards to wildlife associated with the use of a pesticide are summed up in the environmental impact statement on the label.

____ 5) The brand name and the chemical name of a pesticide are often the same.

____ 6) All pesticide labels carry the words, KEEP OUT OF REACH OF CHILDREN — regardless of their level of toxicity.

____ 7) The purpose for which you intend to use a particular pesticide must appear on the label when you buy the product.

____ 8) First aid treatment is only on the labels of liquid formulations of pesticides.

____ 9) Various types of formulations of the same pesticide always carry the same signal word as a precaution.

____10) Half-gallon soda pop bottles make good containers to store leftover pesticides.

Circle correct answer:

11) In the development of a new pesticide, performance data must be collected:
   A) Only for each pest to be controlled
   B) Only for each kind of crop or animal on which it will be used
   C) For each pest to be controlled and for each crop or animal on which it will be used
   D) Only for effect on wildlife
   E) None of these

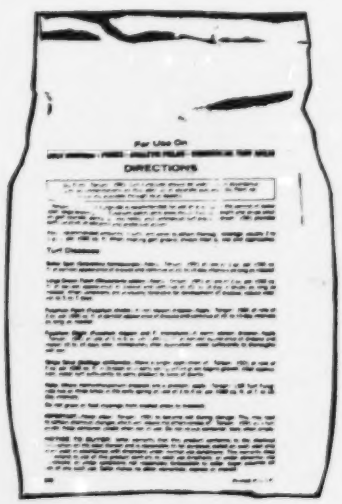
12) The number of days that must elapse from time of application of a pesticide until harvest or slaughter offers a guideline:
   A) As to how long it takes the pesticide to degrade and disappear from the crop or animal
   B) The time left to get your harvesting equipment repaired
   C) As to the number of days when the next application must be made
   D) To danger to beneficial birds
   E) None of these

13) The label lists the registered uses for the pesticide and:
   A) The pesticide should not be used for any other purpose or in any other manner not given on the label
   B) We can substitute it for any other pesticide with equal toxicity
   C) We can use the product if we know it works regardless of label directions
   D) Color of contents
   E) Weight per tablespoon

14) The most hazardous pesticide to the operator carries the signal word
   A) Warning
   B) Danger
   C) Caution
   D) Lethal
   E) Toxic

15) Once you have read the label on a pesticide container, you should:
   A) Tear it off and file in a "label file"
   B) Leave it alone and forget about it
   C) Leave it intact on the original container so you can refer to it often
   D) Give to your neighbor
   E) None of these

Answers
1 T
2 F
3 T
4 T
5 F
6 T
7 T
8 F
9 F
10 F
11 C
12 A
13 A
14 B
15 C



Lesson 9
PESTICIDE SAFETY

Almost all pesticide accidents involve carelessness with or misuse of chemicals. These accidents can damage plants, livestock, or wildlife, but more importantly, accidents can endanger your life or the lives of others. To avoid pesticide dangers, know the material and how to use it. Read the label carefully and follow all directions. Attitude, common sense, knowledge, and training are important. Pesticides are safe, effective, and efficient if used properly. Remember, "Safety Is No Accident."

Misuse of pesticides caused these illnesses, injuries, and deaths reported in 1969:

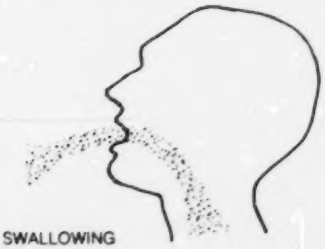
Age	Pesticide Related Incidents*	Percent
Under 5	3,952	68.8
5 and over	925	16.1
Unknown	870	15.1
Total	5,747*	100.0

*Twenty-six of these were deaths (less than ½ percent).

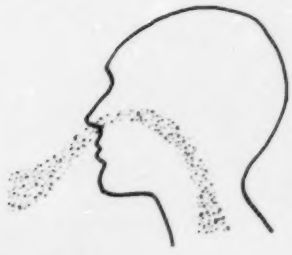
Most pesticide accidents involving man were caused by excessive amounts of chemicals being absorbed into the body. Any chemical is poisonous or toxic if it is absorbed in an excessive amount (see Lesson 6). For example, common table salt is poisonous if a pound is consumed at one time. The toxic effect depends on both the chemical and the amount.

THE THREE WAYS THAT TOXIC CHEMICALS MAY ENTER THE HUMAN BODY

1 THROUGH THE SKIN



2 SWALLOWING



3 BREATHING

There are three ways that toxic chemicals may enter the human body:

1) Absorption through the skin. When someone comes in contact with a chemical, a certain amount may collect and remain on the skin and be absorbed into the body. Accidents may occur during mixing or handling the concentrated chemicals or when people enter a treated area. A thorough washing of all exposed skin is necessary to remove harmful materials and prevent continued absorption. It is also important to change clothing if it has become contaminated with the chemical.

2) Swallowing or gastrointestinal absorption. A certain amount of toxic chemical may be absorbed by swallowing, even from licking your lips or eating lunch without thorough washing. Highly toxic materials should only be used with proper protective equipment. Don't put cigarettes or food in your mouth while using these chemicals and wash thoroughly before eating.

3) Absorption by breathing. Absorption through the lungs following inhalation (breathing) of contaminated air is a common way that poisons enter the body. Many worker-accidents take place in this way. The proper use of a protective respirator (mask) is essential to prevent inhalation of toxic dusts, vapors, etc.

Precautions

The best way to avoid accidents is to take precautions to prevent the incident *before* it happens. Every pesticide user should

thoroughly familiarize himself with the chemical and the regulations for its use.

The manufacturer of toxic pesticides is required by law to put certain information on the label of his product (see Lesson 8). The label tells you what you need to know to use the pesticide safely and effectively. The label alerts you, the user, to potential hazards. But the law can do its job only if you read and follow the label directions. Most accidents are not a result of pesticide use but of misuse. A primary source of trouble has been the failure to keep toxic chemicals away from small children. Another is failure to use protective clothing and respirators.

Be especially careful when preparing the spray mix. The concentrated form of many pesticides is poisonous if absorbed through the skin. Rubber gloves should always be used when mixing the concentrated form of any pesticide. For very toxic materials, a respirator and eye shield must be worn to prevent inhalation or splashing of the material in the eyes.

In mixing chemicals, all quantities of the active ingredients should be measured accurately. Measures for ounces, pints, quarts, and gallons should be kept in the area where chemicals are stored. These measures should be thoroughly washed after use. Keep separate measures for herbicides.

Follow these specific precautions to protect workers or others in the area:

1) *Read the label* and observe all precautions.

2) Do not let children play around sprayers or other applicators, mixing and filling areas, or where pesticides are stored or used.

3) Stay out of an area just recently treated.

4) Wash hands with soap and water before eating or smoking.

5) Wash entire body including hair each day after using pesticides.

6) Put on clean clothes after a day's work in sprayed fields or orchards.

7) Clothes worn while using pesticides should be washed separately from the family wash. Wash twice if heavily contaminated or if a highly toxic organophosphate such as parathion was used.

8) Do not take food or beverages to a treated area. Do not eat any recently sprayed fruit or vegetable without washing.

9) Do not allow anyone other than those making the application in or near the area being sprayed.

10) Work in pairs when using highly toxic materials.

11) Be sure any worker who handles pesticides is knowledgeable about pesticide hazards and safety and knows the antidotes for materials being used.

12) If you feel sick, go to a doctor as soon as possible. Know what chemicals were used. If possible, take the label with you.

13) Know the location of the nearest Poison Control Center. Consult your local telephone directory, call the operator or local hospital, or contact your cooperative Extension office or state's health department for this information. Prominently post name and telephone number of the center.

WATERPROOF SPRAY SUIT

NATURAL RUBBER GLOVES

CARTRIDGE RESPIRATOR

Protective clothing and equipment

Avoid inhaling chemical sprays or dusts whenever possible. Follow label directions — wear a protective respirator and protective clothing if the label tells you to do this. As stated earlier, many pesticide poisonings occur through breathing.

Cartridge respirators protect against small concentrations of gases, vapors, and sprays because a chemical filter purifies inhaled air. These cartridges contain special materials which remove pesticide contaminants as well as dust and other particles.

The respirator usually is a rubber half-mask that covers the nose and mouth. One or two cartridges are attached; a one-way valve allows air to be drawn in through the cartridges but prevents exhaled air from going through. Goggles may be worn with a respirator to provide eye protection — especially important during the mixing process.

When you use a gas mask or respirator, use the correct type for the chemical being handled or applied — they should have approved cartridges or canisters for the particular chemical being used.* The cartridges or canisters are the portion of the gas mask or respirator that actually removes the harmful fumes, dusts, vapors, gases, etc. They should be changed according to directions so you are properly protected. Wash the respirator daily following use.

Protective spray clothing may range from long sleeve shirt, trousers, head covering, and waterproof boots or shoes to a rubber suit with hood and waterproof gloves. Check the pesticide label for clothing recommendations.

Applicators should wear tightly woven, long sleeve shirt and trousers or long sleeve coveralls. Tuck gloves inside sleeves to prevent liquid from running into gloves. Never spray "bare back" or in tee shirts or shorts. Wear a brimmed hat, preferably waterproof, to protect the neck and ears as well as the face.

If you expect your shirt, trousers, or coveralls to become soaked, wear either a rubber suit or some other waterproof jacket or covering. Wear waterproof boots or shoes with pant legs on the OUTSIDE. Use unlined, cuffed, natural rubber or latex gloves when handling or applying highly toxic or concentrated pesticides. Turn the gloves inside out for proper cleaning.

*Approval granted by either United States Department of Health, Education and Welfare, National Institute of Occupational Safety and Health, or United States Department of the Interior, Bureau of Mines.

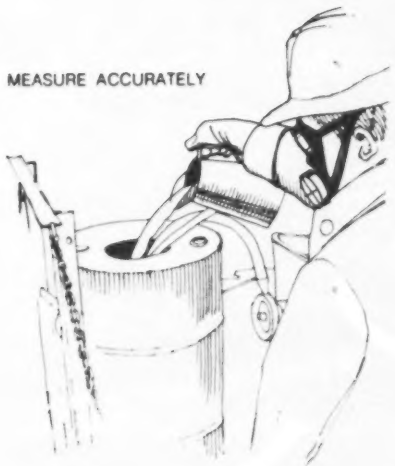
Application safety

Do not permit an irresponsible or careless employee to handle, mix, or apply any pesticide. He may harm himself or others. Some workers cannot read the instructions on the labels; others may not care. Ability and attitude are equally important for the safe, effective use of chemicals.

Double check to be sure you have properly identified the insect, weed, or other pest that you want to eliminate and that you have selected the proper chemical to control it. You may find that a less toxic material is just as effective as one of greater toxicity and therefore is much safer to use.

For example, either malathion or guthion may be used for control of cereal leaf beetle on oats. However, malathion is less toxic and therefore safer to use.

Use chemicals on the crops for which they are recommended. This rule is very important. An entire crop can be destroyed by spraying it with the wrong chemical. In addition to injuring the crop, there may be a residue on the crop that would destroy its usefulness. Mixing two or more chemicals in the tank may be safe and effective on one crop but may badly burn another. Following the instructions on the label can prevent this type of crop damage or injury to you.


MEASURE ACCURATELY

Measure ingredients accurately and mix them thoroughly. *Use the exact amounts as directed on the label.* It is often unsafe, as well as uneconomical, to use more. An excess may actually reduce the ability of the chemical to do its job. When using pesticides, the old saying, "I'll use a little extra to make sure I get the job done," does not hold true. It may work in reverse. When the mixture is too concentrated, exposure to humans or animals is greatly increased during mixing and handling; too high rates may exceed tolerances on harvested crops.

Mix only the amount of pesticide that you need for immediate use. This eliminates leftover mixtures in sprayers, dusters, or even in open containers. Leaving pesticides around creates special hazards to small children, livestock, or pets. If you should have pesticides remaining, store them in a safe container or dispose of them in a safe manner.

Keep your sprayer or applicator in good condition and operating properly. Are you using the recommended type of equipment? For example, don't attempt to use a powder that is intended to be dissolved in water in a dust applicator. The label explains what types of applications are permissible. Use separate equipment for applying 2,4-D-type herbicides. It is not advisable, for example, to use spraying equipment which has contained the herbicide 2,4-D for spraying insecticides or fungicides on susceptible crops. If you use this same equipment for applying other pesticides, accidental injury to the plants will occur unless the equipment has been thoroughly cleaned with an approved material (review Lesson 7 on pesticide application equipment).

Apply chemicals only at times recommended on the label. *There are restrictions on chemical applications to crops due to be harvested.* Observe label directions and cautions to keep residues on edible portions of plants within limits permitted by law. Do not apply chemicals too close to harvest times. Farmers and producers have a legal obligation to follow label restrictions to keep illegal or harmful residues out of products that they are marketing.

The Food and Drug Administration checks products on the market for residues above the legal limits. A crop containing residues above these limits can be ordered destroyed or restricted from sale.

For example, the tolerance limit for carbaryl (Sevin) in or on tomatoes is 10 ppm.

Guard against drift of sprays or dusts. Drift can be reduced or controlled by making the application when there is no wind. Some chemicals are capable of drifting for miles if the right conditions exist. The most important of these conditions are wind speed and direction.

Cover all food and water containers when treating an area near livestock. Use the same precautions when spraying or dusting around your home. Serious injury or death to persons or animals can occur by not following directions. Do not spray or dust close to farm ponds. The chemicals may be harmful to fish or to livestock that may drink from the pond. When a farm pond is used for domestic water supply, be especially careful not to contaminate the water. Stay a safe distance away from any pond and be sure the wind will not carry drift to the water.

Consider wildlife as well as humans, domestic animals, and plants when applying pesticides. Conservation officials and wildlife enthusiasts are very concerned about the possible damage pesticides may cause. If properly handled, chemicals can control pests and not endanger wildlife.

Storage of farm chemicals

INSECTICIDES SHOULD BE STORED WHERE CHILDREN AND PETS CANNOT REACH THEM

Always store chemicals in their original containers, with the label attached and the container tightly closed. Using soda pop bottles, fruit jars, or other types of containers can have serious consequences. Small children associate various shaped containers with their original contents and may be injured or killed by careless use of containers. Never leave excess pesticide mixtures in unmarked containers. You could be responsible for someone's injury or death because you left poisons in unmarked containers.

Keep all chemicals out of the reach of children, pets, and irresponsible people. Do not store them in your home near food. This will help reduce the exposure hazard and also prevent possible contamination of food. LOCK ALL CHEMICALS. The lock should keep everyone out of the chemicals except those who are qualified to use them properly. Remember anything children can get their hands on they may put in their mouths.

Keep chemicals away from livestock feeds to prevent possible contamination. Livestock are frequently killed in this manner. Crop seeds should not be contaminated with chemicals because this may prevent germination.

Never lend a portion of a chemical to another person in an unmarked or unlabeled container. This is dangerous and illegal. Someone other than the person to whom you gave the chemical may use it by mistake and injure himself or others, or the person who uses it will not have the label giving directions for its proper and safe use. Don't rely on oral directions.

Chemicals in large containers which are heavy to handle should be stored on or near the floor to prevent falling; extremely heavy containers should be on the floor to prevent breaking a shelf.

Disposal of containers

A recent innovation, designed to solve the problem of disposal of empty pesticide containers, is to package spray material in a water soluble package that will dissolve in the spray tank. However, spray and other materials will continue to be packaged in conventional containers.

Be sure a container is completely empty before you throw it away. The National Agricultural Chemicals Association recommends the following quick and easy procedure for spray materials:

1) Empty container into spray tank. Then drain in vertical position for 30 seconds.

2) Add rinse water so container is ¼ full; for example, 1 quart for a 1 gallon container.

3) Rinse container thoroughly, pour into tank, and drain 30 seconds. Repeat three times.

DISPOSE OF CONTAINERS PROPERLY

Empty pesticide containers are very dangerous. There have been many cases of deaths or illnesses caused by discarded pesticide containers. Children are often the victims of such accidents because they may play with these containers. Rain washing over empty containers has also been known to carry herbicides into fields, resulting in crop damage.

Use a specially designated landfill site if available. Most empty paper or cardboard pesticide containers can be burned. A special pesticide incinerator is the best choice if available in your region. If not, burning in an open area is acceptable if permitted by local laws or ordinances. Be sure you are away from and downwind from populated areas. Avoid large fires by burning pesticide containers each day and never more than 50 pounds of empty containers at one time. Never burn containers that held mercury, lead, cadmium, arsenic, or inorganic pesticides. Extreme care must be taken not to inhale the smoke from burning containers. Bury the ashes. Empty cans (except pressurized

cans) or small drums should be punched with holes to prevent reuse. They should then be buried at least 18 inches underground. Glass containers should be broken and buried. Check with local authorities to be sure that burial of containers is permitted. Large steel drums can be reconditioned at recycling centers. Ask the manufacturer or dealer for information on recycling. Read the pesticide label for specific instructions on the disposal of empty containers.

Surplus solutions of pesticides are a very serious problem. No more solution should be mixed than can be used at one time. Excess pesticide solutions should all be disposed of in one place; pour into hole dug in level ground and cover with soil to a depth of at least 18 inches. Perhaps a part of a farm could be set aside and fenced off for this purpose. This area would be used only for disposing of surplus spray and for cleaning equipment. Such an area should be located away from ditches, creeks, and streams and in an area where the water table is not high.

CALL YOUR DOCTOR

Pesticide poisoning

Symptoms of poisoning may appear almost immediately after exposure or may be delayed for several hours depending on the chemical, dose, exposure time, and the individual. Symptoms are headache, giddiness, nervousness, blurred vision, cramps, diarrhea, "numb-all-over" feeling, or abnormal size of eye pupils. In some cases, there is excessive sweating, tearing, or mouth secretions. Severe cases of poisoning may be evidenced by nausea and vomiting, fluid in the lungs, changes in heart rate, muscle weakness, breathing difficulty, confusion, convulsions, coma, or death. However, pesticide poisoning may mimic brain hemorrhage, heat stroke, heat exhaustion, hypoglycemia (low blood sugar), gastroenteritis (stomach and intestinal infections), pneumonia, asthma, or other severe respiratory infection.

If poisoning is present or suspected, regardless of how trivial the exposure may seem, obtain medical advice at once. If a physician is not immediately available by phone, take the person directly to the emergency ward of the nearest hospital and take along the pesticide label and telephone number of the closest Poison Control Center.

If a period of time will elapse before medical assistance can be obtained, first aid treatment may be necessary. First read the label on the pesticide container and carefully follow first aid instructions (exception — when breathing has stopped, start artificial respiration at once). If two persons are present, one should give first aid and the other should retrieve the pesticide container and call a physician. Tell him the name of the pesticide, the symptoms, and ask for instructions.

IF A PESTICIDE HAS BEEN SWALLOWED. The most important choice one must make when aiding a person who has swallowed a pesticide is whether or not to induce vomiting. The decision

must be made quickly and accurately; the victim's life may depend on it. Usually it is best to void the swallowed poison fast . . .BUT:

KNOW YOUR POISON CONTROL CENTER PHONE NUMBER

Never induce vomiting if the victim is unconscious or is in convulsions. The victim could choke to death on the vomitus.

Never induce vomiting if the victim has swallowed petroleum products (kerosene, gasoline, oil, lighter fluid). Many pesticides which are formulated as solutions or emulsifiable concentrates are dissolved in petroleum products. The words "emulsifiable concentrate" or "solution" on the pesticide label are signals NOT to induce vomiting if the poison victim has swallowed one of the above formulations. Concentrated petroleum products like corrosive poisons can cause severe burns. They can burn as severely when vomited. If a person swallowed a *dilute* preparation of one of these formulations, he should be forced to vomit immediately.

Never induce vomiting if the victim has swallowed a corrosive poison — a strong acid or alkali (base). Determine what poison the person has ingested. The victim may experience severe pain and have severe mouth and throat burns. A corrosive poison will burn the throat and mouth as severely coming up as it did going down.

How to induce vomiting

Do not waste a lot of time inducing vomiting. Use only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not let him lie on his back because vomitus could enter the lungs and do additional damage.

First give the patient large amounts of milk or water to dilute the poison. Milk is better than water because it dilutes and helps neutralize the poison. Give one to two cups to victims up to five years old; up to a quart to victims five years and older.

To induce vomiting, put your finger or the blunt end of a spoon at the back of the throat. Do not use anything which is sharp or pointed! A glass of soapy or strong salt water will also induce vomiting.

Collect some of the vomitus for the doctor; he may need it for chemical tests.

To neutralize acids. If you are sure that the poison is an acid, give the patient milk of magnesia (one tablespoon to one cup of water), baking soda, or chalk in water.

To neutralize alkali. If you are sure that the poison is an alkali, give the patient lemon juice or vinegar.

Universal sponge

Use these "sponges" to absorb excess poisons only after first-aid suggestions for the corrosive or noncorrosive poisons are followed.

Activated Charcoal — it absorbs many poisons at a high rate. Mix it with water into a thick soup for the victim to drink. Activated charcoal is found in acquarium filters or is available from a drug store. In a poisoning emergency, "Grosafe" — a commercial preparation of activated charcoal, may be substituted for a pharmaceutical grade of activated charcoal.

Homemade Absorber — a homemade "universal sponge" for poisoning is a mixture of four tablespoons of toast (burned black), two tablespoons of strong tea (instant ice tea mix will do), and two tablespoons of milk of magnesia. This can be used to absorb and/or neutralize most poisons.

Warning: Atropine can be poisonous if misused. It should never be used to prevent poisoning. Workers should not carry atropine for first-aid purposes. It should be given only under a doctor's directions.

If a pesticide has been spilled on the skin or clothing. Remove all clothing and wash skin with soap and water immediately. Some pesticides are absorbed by the skin very quickly and washing should not be delayed.

If a pesticide has been inhaled . . . Follow prompt, on-the-spot action. Carry the patient outdoors or to a room free of gas and have him lie down. Remove contaminated clothing and keep him warm. Administer first aid treatment immediately. If breathing has stopped, give artificial respiration. Call a physician immediately. Fumigators should have kits properly equipped with antidotes required for first-aid treatment of a victim of the specific fumigant being used and instructions on treatments that are to be administered only by a physician.

Any time a person feels sick while using a pesticide or shortly afterwards, call a physician immediately. In all cases, make available the pesticide container and any attached labeling. Information on both the container and any attached labels are extremely valuable to the physician. Tell him of all recent contacts with pesticides — the one most obvious to you may not be the one to blame. For example:

> A woman sprayed her flowers twice with malathion using a hand sprayer. On each occasion she thought she was poisoned when she developed headache, nausea, and dizziness. Her family had also sprayed the nearby orchard with what she thought was malathion, but investigation showed parathion had been applied. It also showed that she had worked in the orchard for some days after the application when residues were heavy on weeds. She wore the same dusty "pedal pushers" throughout, and her lower legs were bare. Each illness was preceded by further exposure to residues in the orchard.[1]

If you need additional information on treatment for poisoning, contact your nearest Poison Control Center. They have information covering symptoms and treatment of cases of actual or suspected poisoning by pesticides. This service is available 24 hours a day. Keep phone number handy.

[1]"Diagnosis & Treatment of Poisoning by Pesticides," U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, D.C. 20[illegible]

Keeping records

Every person using pesticides should keep a carefully written record of each application. He should write down:

1) Date and time of application (May 15, 1974, 8-10:30 a.m.)

2) Equipment used (boom sprayer)

3) What chemical was used (atrazine, Sevin, Captan, etc.)

4) The formulation (80 percent wettable powder, 4 pounds/gallon, etc.)

5) The way it was mixed (2½ pounds/20 gallons)

6) What it was used on (crop, animals, storage, ornamentals) and for control of what pest

7) Area treated (10 acres) and rate (20 gal/acre)

8) Weather conditions at the time of application (70°F and very slight breeze)

Certified applicators will be required to keep records. All users should keep records for their own protection. If a farmer's crop is seized for having an illegal residue of pesticides, the records may prove that he did not use the chemicals illegally, thus qualifying him for indemnity payments.

Your personal protection is not the only reason for keeping a pesticide-use record. Many herbicides can also be used on some crops but are fatal to others. Without written records, it is difficult to know what pesticides have been used on a field during the previous few years.

SAMPLE PESTICIDE APPLICATION RECORD

DATE AND TIME	EQUIPMENT	PESTICIDE AND FORMULATION	TOTAL AMOUNT OF PESTICIDE ADDED TO TANK OR HOPPER	TOTAL AMOUNT OF MIXTURE USED	CROP, PEST AND AREA TREATED	ADDITIONAL COMMENTS (Weather, Applicator, Severity of infestation, etc.)
5/13/75 8-10:30 a.m.	ACE Boom Sprayer	Atrazine 80 WP	25 lb.	200 gal.	Corn Field (28) Grasses 10 acres	John Doe No wind
5/15/75	Corn Planter Attachment	Furadan 10G	150 lb.	150 lb.	Corn Field (A) Corn Rootworm 15 acres	40" rows Temp. 60°F
6/21/75	Hand Sprayer	2,4-D EC 4 lb/gal	6 oz.	4 gal.	Pasture Weeds Approx. ¼ acre	Spot Treatment Temp. 85°F Bill Doe

Lesson 9

PESTICIDE SAFETY

Answer the following questions True (T) or False (F).

____ 1) Most pesticide accidents involve misuse or carelessness.

____ 2) Container disposal instructions are part of the pesticide label.

____ 3) If you feel sick when using a pesticide, the best thing to do is to take two aspirins and go to bed.

____ 4) It is alright for adults to work in newly sprayed areas.

____ 5) Respirators need to be worn only on windy days.

____ 6) Protective clothing includes long sleeve shirt and trousers.

____ 7) Pesticides should be stored in a locked location such as separate cabinet, room, or building.

____ 8) Either headache, numbness, or diarrhea may be a symptom of pesticide poisoning.

____ 9) A Poison Control Center has experts on poisoning but they still need the label of the suspected pesticide involved.

____10) Records should be kept of insecticide application but herbicides and fungicides are not important.

Circle correct answer:

11) When mixing pesticides you should mix:
   A) More than you calculate you will actually need to insure a sufficient amount
   B) Enough for 2 day's spraying needs
   C) Only the amount that you need for immediate use
   D) Sufficient to store for future use
   E) Extra for possible use by neighbor

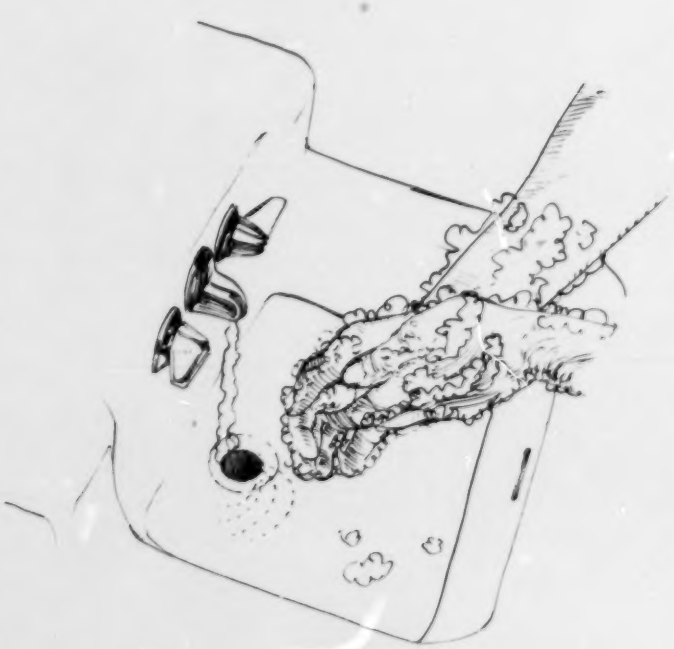
12) Pesticides should be applied only:
   A) After a rain
   B) When convenient to operator
   C) Prior to harvesting of crop
   D) At times recommended on the label
   E) During period of full moon

13) Farm chemicals should be stored:
   A) In any convenient container
   B) Only in their original containers
   C) In containers too heavy for children to handle
   D) In any container tagged with name of contents
   E) None of these

14) Symptoms of pesticide poisoning (One statement is incorrect. Please indicate):
   A) Are uniform in their appearance after exposure
   B) May mimic heat stroke, pneumonia, and intestinal infections
   C) Will appear almost immediately or be delayed several hours depending on the chemical
   D) Most common are headache, giddiness, nervousness, blurred vision, cramps, diarrhea, "numb-all-over" feeling, or abnormal size of eye pupil
   E) May be evidenced by nausea and vomiting

15) When disposing of pesticide containers, the applicator should (One statement is incorrect. Please indicate):
   A) Be sure a container is completely empty before disposal of same
   B) Bury them to a depth of at least 12 inches
   C) Bury the ashes of burned paper or cardboard containers
   D) Break glass containers before burying
   E) Check with dealer for information on containers of a re-cycling nature

Answers
1 T
2 T
3 F
4 F
5 F
6 T
7 T
8 T
9 T
10 F
11 C
12 D
13 B
14 A
15 B



Lesson 10

THE PESTICIDE LAWS FEDERAL AND STATE — Pennsylvania

There has been a sharp increase in the use of chemical pesticides in the past 25 years, not only in the United States but also world wide. Their benefits to mankind have been demonstrated. They have helped control malaria and other insect-vectored diseases; they have helped increase the yields and quality of numerous crops resulting in more food and fiber for more people; and they have helped control nuisance pests. However, the wide scale use — and misuse — of pesticides is also of great concern.

Both the U.S. Congress and the Pennsylvania Legislature recently enacted legislation limiting and controlling the production, transportation, sale, use, and disposal of all pesticides. The Federal Pesticide Act and Rodenticide Act * was amended in 1972. The Pennsylvania Pesticide Control Act of 1973 became a law March 1, 1974.

Purpose of pesticide laws

FIFRA and the Pennsylvania Pesticide Control Act have three purposes: 1) to protect the buyer and user of the product; 2) to protect the consumer of commodities on which pesticides are used; and 3) to protect our environment from hazardous pollutants. The methods used to accomplish these purposes are: 1) truth in labeling — the buyer is assured that the contents in the container meet all of the requirements claimed on the label; 2) regulation of the amounts of hazardous substances that can be sold and the circumstances under which they can be used; and 3) through examination, certification, and licensing of only qualified applicators and dealers. Thus, laws regulate the sale, use, application, and disposal of pesticides.

FIFRA will be fully implemented by October 1976. Some of the major provisions of this act and how these affect you are:

The Environmental Protection Agency can stop the sale or use of any hazardous pesticides. EPA has the authority to issue removal orders and to seize products from the market.

Indemnity payments are paid to persons for a supply of pesticides they are holding before a suspension notice is issued. For example, if you have 500 pounds of an insecticide that you plan to use on your corn and EPA issues a notice that this chemical can no longer be used, you can then collect payment for the insecticide.

Uniform packaging standards for pesticides, including types of containers, size, color, etc.

Regulation of the disposal of pesticide containers and surplus or unwanted pesticides.

Safeguarding the applicator by not permitting the use of any pesticide in any manner or for any use other than that stated on the label. No pesticide can be registered or offered for sale

PROTECT THE OPERATOR!

*Often referred to as "FIFRA Amended" which stands for Federal Insecticide, Fungicide, and Rodenticide Act as amended October 21, 1972.

unless its labeling provides for reasonable safeguards to prevent injury to humans and adverse effects on the environment.

Classification of all pesticides into categories according to their potential hazardous effects for the method and circumstances in which they are to be used. There will be a *general-use* category and a *restricted-use* category. EPA has not yet established which pesticides, formulations, and uses will be under the categories.

General-use pesticides are the pesticides needed and used for farm, household, home gardens, and home grounds pests. They have low toxicity with little potential hazard to humans and the environment. They can be bought and used by the general public without special permit or restriction.

Restricted-use pesticides may be sold only to a *certified applicator* and must be used only by or under the supervision of a certified applicator. All pesticides or formulations or uses in this category may be potentially hazardous. Applicators must know how to use them properly.

Some pesticides may be listed in both categories depending upon the formulation, method of application, and conditions-of-use pattern.

> A concentrated emulsifiable formulation of a certain insecticide would be restricted use if it was applied by aircraft for a shade tree pest. But the same chemical in a low percentage granular formulation would be general use if used as a soil treatment for turf pests.

Implementation of the certification of pesticide applicators by the 50 states through EPA approved programs. Since each state is responsible for implementation of certification, Pennsylvania's program, under the Department of Agriculture, will be explained when the Pennsylvania Pesticide Act is discussed.

Stricter regulations by individual states may be imposed on a pesticide than those in FIFRA, except for labeling and packaging which must be uniform nationwide. State restrictions, however, cannot be more liberal than FIFRA's.

Violators of any provisions of the act are liable to $1,000 penalty on their second and subsequent offenses if they are private applicators. The penalty for commercial applicators and dealers is much greater.

PROTECT THE CONSUMER!
NOT JUST FROM THE WORM
BUT ALSO FROM THE PESTICIDE

Pennsylvania pesticide control act of 1973*

The Pennsylvania Pesticide Control Act is a companion bill to FIFRA: however, the state act defines how the pesticide acts will be administered and regulated. The major aspects of the act, with special reference to Pennsylvania farmers, are:

*Act No. 24, 1974. Copies available from Pennsylvania legislators.

Section 3) "Declaration of Purpose . . . pesticides are valuable to our State's agriculture production and to the protection of man and the environment from insects, rodents, weeds, and other forms of life which may be pests; but it is essential to the public health and welfare that they be regulated to prevent adverse effects on human life and the environment. The purpose of this act is to regulate in the public interest, the labeling, distribution, storage, transportation, use, application, and disposal of pesticides. New pesticides are continually being discovered or synthesized which are valuable for the control of pests, and for use as defoliants, desiccants, plant regulators, and related purposes. The dissemination of accurate scientific information as to the proper use of any pesticide is vital to the public health and welfare and to the environment both immediate and future."

Section 5) Registration. This section is of importance to the manufacturer and distributor.

Section 6) Refusal to register, cancellation, suspension, legal recourse.

a) The Secretary (of agriculture) may refuse to register a pesticide if it does not meet its proposed claims.

b) The Secretary may cancel a registration after giving the registrant an opportunity to present his views to the Secretary, if it does not comply with the act.

c) A pesticide may be suspended from use if it presents an imminent hazard.

Section 8) Prohibited acts.

a) No one shall deliver or transport within Pennsylvania any pesticide unless it is in a sound original container with a label attached.

e) No person shall use any pesticide for any purpose or by any manner other than that stated on the label.

g) "No person shall handle, transport, store,display or distribute pesticides in such manner as to endanger man or his environment or endanger food, feed, or any other products that may be stored, displayed or distributed with such pesticides."

For example, do not haul bags of toxic insecticides on the top of a load of feed or store in the feed room with bags of feed.

h) "No person shall dispose of, discard, or store any pesticide or pesticide containers in such manner as to cause injury to humans, vegetation, crops, livestock, wildlife, or pollinating insects or pollute any water supply or waterway."

j) "No person shall operate pesticide application equipment or devices in a faulty, careless or negligent manner."

k) You shall keep and maintain necessary records on the pes-

PROTECT THE ENVIRONMENT!

ticides you used.

Section 9) Denial, Suspension and Revocation of Licenses, Permits, and Certificates. If a person is found in violation of the regulations, he may have his applicator's certificate suspended or revoked after being given an opportunity to present his views to the Secretary.

Section 10) "Stop Sale, Use, or Removal" Order. If there is reasonable cause to believe that a pesticide is being used in violation of the act, the Secretary can stop the sale and use of such material.

Section 11) Judicial action after "Stop Sale, Use, or Removal" Order. This section defines the legal course of action that will be followed.

Section 12) Pesticide Dealer License. This section states that all pesticide dealers who sell restricted-use pesticides must be licensed.

Section 13) Pest Restricted-Use Management Consultants. Must be licensed.

Section 14) Examination for Pest Management Consultant's License.

Section 16) Commercial Applicator's License. "No person shall engage in the business of applying pesticides classified for restricted use to the lands of another at any time without a commercial applicator's license issued by the Secretary." There will be an annual fee of $30 for each commercial applicator's license issued.

The categories suggested for commercial applicators by EPA are: 1) agriculture pest control — plant and animal; 2) forest pest control; 3) ornamental and turf pest control; 4) seed treatment; 5) aquatic pest control; 6) right-of-way pest control; 7) industrial, institutional, structural, and health-related control; 8) public health pest control; 9) regulatory pest control; and 10) demonstration pest control. There is no fee for private applicator certification. A private applicator cannot apply restricted-use pesticides to another person's property for hire.

Section 17) Private Applicators. This section affects almost every Pennsylvania farmer. A private applicator is defined as "a certified applicator who uses or supervises the use of any pesticide which is classified for restricted use for purposes of producing any agricultural commodity on property owned or rented by him or his employer or (if applied without compensation other than trading of personal services between producers of agricultural commodities) on the property of another person."

a) No "private applicator" can use any pesticide classified for restricted use until he has passed the certification requirements determined by the Secretary as necessary to prevent unreasonable adverse effects on the environment.

b) "To be certified as a private applicator to use pesticides classified for restricted use, a private applicator shall be required to have a permit which signifies that he is competent to use such pesticides."

Section 20) Reports of Pesticide Accidents, Incidents, or Loss. Significant pesticide accidents *may* need to be reported.

Section 21) Inspection of Equipment. There may be inspection of equipment used for application of pesticides.

Section 22) Reciprocal Agreement. Certification of applicators can be on a reciprocal basis with other states.

Section 23) Exemptions. A farmer who qualified as a certified private applicator does not have to pay for a permit.

b) "A landscape gardener who does not apply pesticides classified for restricted use is exempt from licensing provisions of this act." He must be licensed as a commercial applicator to apply restricted-use pesticides.

Section 24) Pennsylvania will use the procedures and regulations of EPA for the safe disposal or storage of any pesticide that has its usage cancelled.

Section 25) Pesticide Advisory Board. The Governor appoints members to a Pesticide Advisory Board who advise the Secretary on any or all problems relating to the use and application of pesticides. Members of this board are:

3 licensed pesticide applicators in the State (one ground applicator, one aerial applicator, and one structural pest control operator);
1 entomologist in public service;
1 environmental health specialist from the Pennsylvania Department of Health;
1 toxicologist in public service;
1 plant pathologist in public service;
1 member of the agricultural chemical industry;
1 member from the food processing industry;
2 producers of agricultural crops;

1 representative each from the State's Department of Agriculture, Pennsylvania Fish Commission, Pennsylvania Game Commission, Pennsylvania Department of Environmental Resources, and the Pennsylvania Department of Transportation.

Section 27) Information. For the purpose of dispensing information needed in certification and other areas, the Secretary may cooperate with The Pennsylvania State University or any other public educational institution and industry associations.

Section 29) Criminal Penalties.

a) Any person who is convicted of violating any provisions of this act are subject to a $300 fine or 90 days imprisonment or both.

c) If a private applicator is convicted of a second and similar offense within three years after the first conviction, he is subject to a $2500 fine or 1 year's imprisonment or both.

Section 33) Enforcement. Inspectors are granted authority to sample and examine pesticides at any distributor's place of business. They may also:

1) Have access to inspect equipment.

2) Inspect lands exposed to pesticides.

3) Inspect storage and disposal areas.

4) Inspect or investigate complaints of injury to humans and land.

5) Sample pesticides being applied or to be applied.

Other regulations

Many farmers will be concerned with the reentry regulations proposed by EPA, the *Occupational Safety and Health Standards for Farm Workers Dealing With Pesticides.*

This part is an extension of FIFRA and deals with safety standards for farm workers who work in fields to which pesticides are applied.

1) All workers other than those applying the pesticide must be out of the field during application.

2) Workers must not reenter the treated field for at least 12 hours after application of most pesticides unless they wear designated protective clothing when they reeenter and while they are in the field. For approximately a dozen pesticides, a 48-hour limit post treatment is in effect. If the field is treated with one of these chemicals, protective clothing must be worn by workers if they enter fields within 48 hours after treatment.

3) After pesticides are applied, workers must be warned that the field has been treated with pesticides and the time when the field can be reentered.

Lesson 10

THE PESTICIDE LAWS
FEDERAL AND STATE — Pennsylvania

Answer the following questions True (T) or False (F).

____ 1) The only purpose of the Federal and State Pesticide Acts is to protect the environment from hazardous pollutants.

____ 2) The Environmental Protection Agency has the authority to stop the sale or use of any hazardous pesticide.

____ 3) You cannot legally use any pesticide in any manner or for any use other than that stated on the label.

____ 4) Pesticides in the restricted-use category can only be used by or under the supervision of a certified applicator.

____ 5) Pesticides in the general-use category will be available for use by the general public.

____ 6) The Pennsylvania Department of Agriculture is designated as the agency to administer the Pesticide Acts in Pennsylvania.

____ 7) Pesticides can be sold and transported in most any kind of container just so they don't leak.

____ 8) A part of the pesticide acts include regulations on the safe methods for disposal of pesticides and empty containers.

____ 9) Faulty pesticide application equipment cannot be used.

____10) A certified private applicator must have a permit which signifies that he is competent to use restricted-use pesticides.

Circle correct answer:

11) Restricted-use pesticides may be sold only:
   A) To a certified private applicator
   B) To a certified commercial applicator
   C) To a certified applicator either private or commercial
   D) To County Extension Agent
   E) To a distinguished looking citizen

12) The agency responsible for the implementation and administration of the pesticide acts in Pennsylvania is:
   A) DER
   B) Pennsylvania Department of Agriculture
   C) Pennsylvania Department of Transportation
   D) Pennsylvania Public Utility Commission
   E) None of these

13) Fees for private applicators certification will be:
   A) $10 per year
   B) No fee
   C) $30 per year
   D) $100 per year
   E) $200 per year

14) Pennsylvania will have a Pesticide Advisory Board to:
   A) Advise the Secretary of Agriculture on problems relating to pesticides
   B) To control the issuing of licenses to certified applicators
   C) To advise the Governor on where to spend monies collected through license fees
   D) Identify insects
   E) Supply advice to teenagers

15) The law will be enforced by State inspectors who will have authority to:
   A) Sample and examine pesticides only at distributor's place of business
   B) Inspect storage and disposal areas upon permission of owner
   C) To sample pesticides at site of application as well as at distributors, and also to inspect storage and disposal areas
   D) Judge your wife's cooking
   E) Select your pesticide dealer

Answers
1 F
2 T
3 T
4 T
5 T
6 T
7 F
8 T
9 T
10 T
11 C
12 B
13 B
14 A
15 C

GLOSSARY

GLOSSARY

ABSORPTION: The uptake of pesticides by the skin, respiratory system, or digestive system; also refers to the uptake of chemicals by the plant through leaves, stems, roots, flowers, or fruit.

ACARICIDE: A pesticide used to control mites and ticks. Same as miticide.

ACTIVATOR: A material added to a pesticide to increase, either directly or indirectly, its toxicity to pests.

ACTIVE INGREDIENT: The chemical or chemicals in a product responsible for preventing, destroying, repelling or mitigating insects, fungi, rodents, weeds, or other pests.

ACTUAL DOSAGE: The amount of active ingredient (not formulated product) which is applied to a specific area or target.

ACUTE ORAL LD_{50}: In toxicity studies, the amount of material fed in a single dose that will kill 50 percent of a test population.

ACUTE TOXICITY: To cause injury or death from a single dose or exposure.

ADHERENCE: The property of a substance to stick to a given surface.

ADJUVANT: Any substance added to a pesticide which improves the activity of the active ingredient. Examples: Penetrants, spreader-stickers, wetting agents.

ADSORPTION: The process by which a pesticide or other chemical is held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides in many instances. (See absorption).

ADULTERATED PESTICIDE: A pesticide that does not conform to the professed standard or quality as documented on its label or labeling.

AEROSOL: A material stored in a container under pressure. An extremely fine mist is produced when the material, dissolved in a liquid gas, is released into the air from the pressurized container.

AGITATION: Process of keeping a pesticide mixed in the spray tank in order to keep it from settling or separating out of suspension.

ALGAE: Relatively simple plants that contain chlorophyll and are photosynthetic.

ALGAECIDE (ALGICIDE): A pesticide used to kill or inhibit the growth of algae.

AMPHIBIANS: Animals of the class Vertebrata that are intermediate between fish and reptiles. They are cold-blooded and have moist skin without scales, feathers or hair. Examples: Frogs, toads, salamanders.

ANNUAL: A plant that grows from seed and produces seed all in the same year, then dies.

ANTAGONISM: The phenomenon which results in a reduction of activity of an organism or chemical when two or more different kinds are mixed together or occur in close proximity to one another.

ANTIBIOTIC: A chemical usually produced by a microorganism which is injurious to other organisms. Examples: Streptomycin, cycloheximide.

ANTICOAGULANT: A chemical which prevents normal blood-clotting. The active ingredient in some rodenticides.

ANTIDOTE: A practical treatment, including first aid, used in the treatment of pesticide poisoning or some other poison in the body.

ANTI-SIPHONING DEVICE: A device attached to a filling hose to prevent water from the spray tank from draining back into the water source.

ANTI-TRANSPIRANT: A chemical applied directly to a plant which reduces the rate of transpiration or water loss by the plant.

APICULTURE: Pertaining to the care and culture of bees.

ARSENICALS: Pesticides that contain arsenic.

ATROPINE (ATROPINE SULFATE): An antidote used to treat organophosphate and carbamate poisoning.

ATTRACTANTS: Substances or devices which attract insects or other pests to areas where they can be trapped or killed.

AVICIDE: A chemical used to kill birds.

BACTERIA: Microscopic organisms, some of which are capable of producing diseases in plants and animals.

BACTERICIDE: Chemical used to kill bacteria.

BAIT: A food or other substance used to attract a pest to a pesticide or to a trap where it will be destroyed.

BAND APPLICATION: The application of a pesticide or other material to a limited area such as in or beside a crop row rather than over the entire field area. (See broadcast application).

BIENNIAL: A plant that completes its life cycle in two years. The first year it produces leaves and stores food. Fruit and seed are produced only during the second year of growth.

BIOLOGICAL CONTROL: Control of pests without the use of pesticide chemicals. Predators, parasites and disease producing organisms can be used to control pests.

BOTANICAL PESTICIDE: A pesticide produced from naturally occurring chemicals found in some plants. Examples are nicotine, pyrethrum, strychnine and rotenone.

BRAND: The name, number, or designation of a pesticide product or device made by a manufacturer or formulator. The same as the trade name.

BROADCAST APPLICATION: The application of a pesticide or other material over an entire field or area.

BROADLEAF PLANTS: Those plants having broad, rounded or flattened leaves with net veins as opposed to the narrow blade-like leaves with parallel veins of grasses, sedges, rushes and onions.

BROAD SPECTRUM PESTICIDES: General purpose pesticides which can be used against a large number of pests on a wide range of crops.

CALIBRATE - CALIBRATION: To determine the amount of pesticide that will be applied to the target area.

CARBAMATE PESTICIDES: A group of pesticides containing the element nitrogen and formulated as insecticides (Sevin, Furadan, Lannate), fungicides (Zineb, Maneb), and herbicides (IPC, CIPC).

CARCINOGEN: A substance or agent which produces cancer.

CARCINOGENIC: The property of a substance or agent to produce cancer.

CARRIER: A liquid, solid, or gas that is added to the active ingredient in the manufacture of a pesticide formulation. Also, a material, usually water or oil, used to dilute the formulated product immediately prior to application.

CAUSAL ORGANISM: The organism (pathogen) that produces a given disease.

CAUTION: See signal word.

CHEMICAL NAME: Scientific name of the active ingredient(s) found in the formulated product. The name is derived from the chemical structure of the active ingredient.

CHEMOSTERILANT: A chemical compound capable of producing reproductive sterilization.

CHEMOTHERAPY: The treatment of a desired plant or animal with chemicals to destroy or control disease producing organisms within the plant or animal.

CHLORINATED HYDROCARBON: A group of pesticides which contain chlorine, carbon and hydrogen. These pesticides are generally very persistent in the environment. Examples: Chlordane, DDT, methoxychlor.

CHLOROSIS: The yellowing of a plant's normally green tissue because of a breakdown of chlorophyll or the failure of the chlorophyll to develop.

CHOLINESTERASE: A chemical catalyst (enzyme) found in animals that reduces nerve impulses.

CHRONIC TOXICITY: To cause injury or death from repeated, prolonged exposure to small amounts of a pesticide or other agent. (See acute toxicity).

COMMON PESTICIDE NAME: A common chemical name given to a pesticide by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names but have only one recognized common name. Example: The common name for Sevin insecticide is carbaryl.

COMPATIBLE: Two or more pesticides are said to be compatible when they can be mixed together without reducing the effectiveness of any of the individual components.

CONCENTRATE: A pesticide as it is sold before dilution; usually contains a high percentage of active ingredient.

CONCENTRATION: Refers to the amount of active ingredient in a formulated pesticide or in a mixture.

CONIFER: Trees and shrubs with needle-like or scaly leaves. Most are evergreen such as pine, cedar, spruce, and hemlock. Larch is a deciduous conifer.

CONTACT HERBICIDE: A chemical that kills primarily by contact with plant tissue with little or no translocation. Only that portion of the plant that comes in direct contact with the herbicide is affected.

CONTACT INSECTICIDE: A compound that causes the death of an insect when it touches its external parts. It does not need to be ingested to be toxic to the insect.

CONTAMINATION: The presence of an unwanted pesticide or other material in or on a plant, animal, or their by-products; soil; water; air; structure; etc. (See residue).

COVERAGE: The spread of a pesticide chemical over a surface such as the leaves, fruit, stem, etc.

CUMULATIVE PESTICIDES: Those chemicals which tend to accumulate or build up in the tissues of animals or in the environment (soil, water).

CURATIVE PESTICIDE: A pesticide which can inhibit or eradicate a disease causing organism after it has become established in the plant or animal.

DANGER-POISON: See signal word.

DAYS TO HARVEST: The minimum number of days permitted by law between the final pesticide application and the harvest of the crop. (Same as preharvest interval).

DECIDUOUS PLANTS: Perennial plants that lose their leaves during the winter.

DECONTAMINATE: The removal or breakdown of any pesticide chemical from any surface or piece of equipment.

DEFOLIANT: A chemical which causes the leaves or foliage to drop from a plant.

DEGRADATION: The process by which a chemical compound is reduced to a less complex compound by the action of microorganisms, water, air, sunlight, or other agents.

DEPOSIT: The amount of pesticide remaining on the plant, plant part, or other surface at any time after it is applied.

DERMAL TOXICITY: The property of a pesticide to poison an animal or human when absorbed through the skin.

DESICCANT: A chemical that promotes drying or loss of moisture.

DETERIORATE: To break down or wear away, to decay.

DETOXIFY: To make an active ingredient in a pesticide or other poisonous chemical harmless and incapable of being toxic to plants and animals.

DILUENT: Any liquid or solid material used to dilute or carry an active ingredient.

DISINFECTANT: A chemical or other agent that kills or inactivates disease producing microorganisms in animals, seeds, or other plant parts. Also, commonly referred to chemicals used to clean or surface sterilize inanimate objects.

DISPERSING AGENTS: Chemicals added during the preparation of pesticide sprays to facilitate wetting and suspension of the product.

DISPOSAL: The process of discarding or throwing away unused spray material, surplus pesticides, and pesticide containers.

DORMANT SPRAY: A pesticide application prior to the emergence of leaves and other vegetation in the spring.

DOSE, DOSAGE: Quantity of pesticide applied to a given area or target.

DRIFT: The airborne movement of a pesticide spray or dust from the target area to an area not intended to be treated.

DUST: A finely ground, dry pesticide formulation usually containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

EMULSIFIABLE CONCENTRATE: A pesticide formulation produced by dissolving the active ingredient and an emulsifying agent in a suitable solvent. When added to water an emulsion (milky mixture) is produced.

EMULSIFYING AGENT: A chemical which aids in the suspension of two liquids which would normally not mix readily together.

EMULSION: A mixture of two liquids which are not soluble in one another. One is suspended as very small droplets in the other with the aid of the emulsifying agent. Example: Oil in water.

ENCAPSULATION: A technique to dispose of pesticides and pesticide containers. Waste pesticides and empty containers are sealed in waterproof containers so the contents cannot contaminate the environment. Also, a method of formulating certain pesticides and fertilizers principally for slow release.

ENVIRONMENTAL PROTECTION AGENCY (EPA): The federal agency responsible for pesticide rules and regulations, and all pesticide registrations.

EPA REGISTRATION NUMBER: A number assigned to a pesticide product by EPA when the product is registered by the manufacturer or his designated agent. The number must appear on all labels for a particular product.

EPA ESTABLISHMENT NUMBER: A number assigned to each pesticide production plant by EPA. The number indicates the plant at which the pesticide product was produced and must appear on all labels of that product.

ERADICANT: A chemical or other agent (steam, heat) used to eliminate a pest from a plant, animal, or a place in the environment (soil, water, buildings, etc.). (See chemotherapy).

ERADICATION: The complete elimination of either weeds, insects, disease organisms, or other pests from an area.

FLOWABLE: A type of pesticide formulation in which a very finely ground solid particle is mixed in a liquid carrier.

FOAMING AGENT: A chemical which causes a pesticide preparation to produce a thick foam. This aids in reducing drift.

FOG TREATMENT: The application of a pesticide as a fine mist for the control of pests.

FORMULATION: A pesticide product containing a mixture of one or more active ingredients, carriers, and other additives needed to make it reasonably safe and easy to handle, dilute, and apply.

FUMIGANT: A chemical that forms vapors (gases) which is used to destroy weeds, plant pathogens, insects, or other pests.

FUNGI (singular: FUNGUS): Nonchlorophyll bearing plants, some of which are able to infect and cause diseases in plants, animals, and man. Others can attack and destroy nonliving things such as wood and fiber products. Examples: Rusts, mildews, molds, smuts.

FUNGICIDE: A chemical that kills or inhibits fungi.

FUNGISTATIC AGENT: A chemical that prevents the germination of fungus spores or the growth and development of mycelium while in continued contact with the fungus, but does not kill the fungus.

GENERAL-USE PESTICIDE: A pesticide which can be purchased and used by the general public without undue hazard to the applicator and environment as long as the instructions on the label are followed carefully. (See restricted-use pesticide).

GERMINATION: Refers to the sprouting of a seed or the production of a germ tube (mycelium) from a fungus spore.

GRANULE: A pesticide formulation in which the active ingredient is either mixed with or absorbed-adsorbed on an inert carrier to form a small, ready to use, low concentrate, uniform-sized pellet which does not normally present a drift hazard.

GROWTH REGULATOR: A chemical, usually effective in minute amounts, which alters the growth processes of a plant or animal. (See plant growth regulator).

HERBACEOUS PLANTS: Plants that do not develop woody tissues.

HERBICIDE: A pesticide used for killing or preventing plant growth. A weed or grass killer.

HYDRAULIC: Pertaining to water or other liquid.

ILLEGAL RESIDUE: The amount of active ingredient above the tolerance which remains on a crop at harvest. In some cases, any amount of chemical present on the crop is considered illegal. (See tolerance).

IMPERMEABLE: Not capable of being penetrated.

INACTIVE: Not capable of reacting chemically or a material present in a pesticide product which has no effect on living organisms.

INCOMPATIBLE: Two or more materials which cannot be mixed or used together.

INERT INGREDIENT: An inactive material in a pesticide formulation which does not contribute to the toxicity of the active ingredient.

INGEST: To eat or swallow.

INGREDIENT STATEMENT: That portion of the label on a pesticide container which gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION TOXICITY: To be poisonous to man or animals when breathed into the lungs.

INSECTICIDE: A pesticide that is used to kill, inhibit, repell, or otherwise prevent damage caused by insects.

INTEGRATED CONTROL: The use of two or more methods of control to prevent damage by pests. These include cultural

practices, use of biological control agents, and the use of selective pesticides.

JET (HYDRAULIC) AGITATOR: A device that keeps a tank mix from settling out of suspension by means of water flowing under pressure.

LABEL: All printed material attached to or part of the pesticide container.

LABELING: Supplemental pesticide information which complements the information on the label, but is not necessarily attached to or part of the container.

LC_{50}: The concentration of an active ingredient in a pesticide which can kill 50 percent of a test population of animals exposed to the chemical. LC_{50} is often used to measure the toxicity of a chemical present in air or water. LC_{50} is often expressed in parts per million (ppm). The *lower* the LC_{50} value, the *more poisonous* the chemical.

LD_{50}: The dose or amount of active ingredient in a pesticide which can kill 50 percent of the test animals exposed to the chemical. LD_{50} is used to measure the acute oral and dermal toxicity of a chemical. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The *lower* the LD_{50}, the *more poisonous* the chemical.

LEACHING: The movement of a pesticide chemical or other substance downward through soil as a result of water movement.

MAMMALS: Animals of the class Vertebrata which are warm-blooded, possess hair, and nourish their young with milk. (See vertebrate animals).

MAXIMUM DOSAGE: The largest amount of a pesticide chemical that can be safely used without damaging the plant, animal, or object which is being protected and which will not result in excess residues.

METABOLITE: In the case of pesticides, a compound derived from an active ingredient through chemical, biological, or physical action. The metabolite may either be simpler or more complex and may or may not be poisonous.

MICROBIAL PESTICIDE: Bacteria, viruses, fungi, and other microorganisms used to destroy or control pests.

MISCIBLE LIQUIDS: Two or more liquids capable of being mixed and which will remain mixed under most conditions. Water and ethyl alcohol are miscible; water and oil are not.

MITICIDE: Same as acaricide.

MOLD: A fungus; usually associated with damp places and decaying material.

MOLLUSCICIDE: A chemical used to kill or control snails and slugs.

MUTAGENIC: The property of a substance or agent to produce genetic changes in living cells.

MYCOPLASMA: A microorganism intermediate in size between viruses and bacteria possessing many virus-like properties and not visible with a light microscope.

NECROSIS: Death of plant or animal tissues which results in discolored, sunken, or otherwise abnormal appearing lesions.

NECROTIC: A term used to describe tissues exhibiting varying degrees of dead areas or lesions.

NEMATICIDE: A pesticide that kills or otherwise controls nematodes.

NEMATODE: A tiny, usually microscopic, worm-like animal that feeds on the roots and other parts of plants. Other types of nematodes are found in soil, water, decaying matter, or as parasites of animals.

NONPERSISTENT PESTICIDE: A pesticide that does not remain active in the environment more than one growing season.

NONSELECTIVE PESTICIDE: A pesticide that is toxic to a wide range of plants or animals without regard to species. Example: A nonselective herbicide may kill or damage all plants.

NOXIOUS WEED: A plant defined by law as being particularly troublesome, undesirable, and difficult to control.

ONCOGENIC: The property to produce tumors (not necessarily cancerous) in living tissues. (See carcinogenic).

ORAL TOXICITY: To cause injury when taken by mouth.

ORGANOPHOSPHATE COMPOUNDS: A large group of pesticides which contain the element phosphorus. They are generally nonpersistent compounds. Many members of this group are highly toxic. Examples: Malathion, parathion, diazinon.

ORIFICE: Opening in a nozzle.

ORIGINAL CONTAINER: The package (bag, bottle, can etc.) in which the pesticide product is sold. The package must contain a label describing how to use the product properly and safely. Never store a pesticide in anything other than the original container.

OVICIDE: A material that destroys eggs.

PARASITE: A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining food, shelter, etc.

PATHOGEN: Any organism or virus capable of causing a disease in a host.

PERENNIAL: A plant that lives for more than two years.

PERSISTENT PESTICIDE: A pesticide chemical (or the metabolites) that remains active in the environment more than one growing season. These compounds often accumulate and are stored in animal and plant tissues. Examples: DDT, chlordane, dieldrin.

PEST: An undesirable organism (insect, fungus, nematode, weed, virus, rodent, etc.) which is injurious to man, plants and animals considered beneficial to man, and man-made or natural products.

PESTICIDE: A chemical or other agent used to kill or otherwise control pests.

PHEROMONE: A substance secreted by an animal to influence the behavior of other animals of the same species.

PHYTOTOXICITY: Injury to plants caused by chemicals or other agents.

PISCICIDE: A chemical used to kill undesirable fish. Some piscicides are selective in their action.

PLANT GROWTH REGULATOR: A substance which either increases or decreases the normal or expected growth, flowering, or reproduction rate of plants. This does not include fertilizers and other plant nutrients. (See growth regulator).

POINT OF RUNOFF: When a spray starts to run or drip off the leaves and stems of plants or the hair or feathers of animals.

POISON: Any chemical or agent that can cause illness or death when eaten, absorbed through the skin, or inhaled by man or animals.

POISON CONTROL CENTER: An agency, generally a hospital, which has current information as to the proper first aid techniques and antidotes for all poisoning emergencies.

POSTEMERGENCE: After the plants have appeared through the soil.

PPM: Parts per million. A means to express amounts of chemicals in food, plants, animals, water, soil, air, etc. One part per million equals 1 lb. in 500 tons.

PRECIPITATE: A solid substance that forms in a liquid and settles to the bottom of a container. A material that no longer remains in suspension.

PREDATOR: An animal that preys on and feeds on other animals. Examples of predacious animals include cats, dogs, hawks, owls, snakes, fish, and many insects.

PREEMERGENCE: Before the plants have appeared through the soil.

PREHARVEST INTERVAL: Same as days to harvest.

PREPLANT PESTICIDE: A pesticide which is applied prior to planting a crop.

PROPELLANT: An inert ingredient in self-pressurized products that produces the force necessary to dispense the active ingredient from the container. (See aerosol).

PROTECTANT: A pesticide applied to a plant or animal prior to the appearance or occurrence of the pest in order to prevent infection or injury by the pest.

PROTECTIVE EQUIPMENT: Equipment, including proper clothing, intended to protect a person from being poisoned during the handling and application of pesticides. This includes long sleeved shirts and long trousers; suitable hats, gloves, shoes; respirators; and other safety items as needed.

PROTOPAM CHLORIDE (2-PAM): An antidote for organophosphate pesticide poisoning, but *not for carbamate poisoning*. (See atropine sulfate).

RATE OF APPLICATION: The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear feet, per cubic feet.

REENTRY INTERVAL: The length of time between the application of a pesticide and when farm workers can safely enter a treated field without protective clothing and equipment.

REGISTERED PESTICIDES: Pesticide products which have been approved by the Environmental Protection Agency for the uses listed on the label.

REPELLENT: A compound that keeps or drives away insects, rodents, birds, or other pests from plants, domestic animals, buildings, or other treated areas.

REPTILES: Animals of the class Vertebrata that are cold-blooded and possess scaly skin. Examples: Snakes, turtles, lizards.

RESIDUAL PESTICIDE: A pesticide that can destroy pests or prevent their damage for long periods following application.

RESIDUE: The amount of active ingredient which remains in or on the target after it has been treated with a pesticide. (See contamination).

RESISTANT: A population of organisms that are uninjured or unaffected by a certain dosage of pesticide chemical used to successfully control other populations of the same organism. Also, plants and animals that are unaffected by a pest species. (See tolerant).

RESTRICTED-USE PESTICIDE: A pesticide which will be available for purchase and use only by certified pesticide applicators. This group of pesticides will not be available for use by the general public because of the very high toxicities and/or environmental hazards associated with these materials.

RODENTS: Animals such as rats, mice, voles, squirrels, and woodchucks.

RODENTICIDE: A pesticide or mixture of pesticides used to kill or control rodents.

SAFENER: A material added to a pesticide to eliminate or reduce phytotoxic effects.

SEED TREATMENT: The application of a pesticide chemical to seeds before planting in order to protect them from injury or destruction by insects, fungi, and other soil pests.

SELECTIVE PESTICIDE: A pesticide that is toxic to some pests, but has little or no effect on other similar species. Example: Some fungicides are so selective that they control only powdery mildews and no other fungi.

SIGNAL WORD: A required word which appears on every pesticide label to denote the relative toxicity of the product. The signal words are either "Danger-Poison" for highly toxic compounds, "Warning" for moderately toxic, or "Caution" for slightly toxic.

SILVICIDE: A pesticide used to destroy woody shrubs and trees.

SOIL DRENCH: To soak or wet the surface of the ground with a pesticide chemical. Generally fairly large volumes of the pesticide preparation are needed to saturate the soil to any depth.

SOIL FUMIGANT: A pesticide which, when applied to the soil, forms a gas to destroy many pests.

SOIL INCORPORATION: The mechanical mixing of a pesticide product with soil.

SOIL INJECTION: The mechanical placement of a pesticide below the surface of the soil with little mixing or stirring. Commonly used to apply those liquids which are converted to gases in the soil. Also, the application of pesticide suspensions, solutions, and emulsions below the surface of the soil by means of a pressure device.

SOIL STERILANT: A chemical or agent which destroys all organisms present in the soil; a nonselective pesticide.

SOLUBLE POWDER: A finely ground, solid material which will dissolve in water or some other liquid carrier.

SOLUTION: Mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: Sugar in water.

SOLVENT: A liquid such as water, oil, alcohol, etc. which will dissolve another substance (solid, liquid or gas) to form a solution.

SPACE SPRAY: A pesticide which is applied as a fine spray or mist to a confined area either indoors or outside.

SPRAY CONCENTRATE: A liquid formulation of a pesticide usually containing a high percentage of active ingredient which can be diluted with another liquid (water, oil) before using. (See ULV).

SPRAY DEPOSIT: The amount of pesticide chemical that remains on a sprayed surface after the droplets have dried.

SPREADER: A chemical added to a pesticide mixture or already included in the formulation which will increase the area that a given volume of liquid will cover on a surface.

STICKER: A chemical added to a pesticide mixture or already included in the formulation which will make the spray droplets stick better to a plant, animal, or surface.

STRUCTURAL PESTS: Pests which attack and destroy buildings and other structures, clothing, stored food, and manufactured and processed goods. Examples: Termites, cockroaches, clothes moths, rats, dry-rot fungi.

STOMACH POISON: A pesticide that must be eaten by an insect or other animal in order to kill or control the animal.

SURFACTANT: A chemical or agent which, when added to a pesticide mixture, increases the spreading and wetting properties of a pesticide preparation. Examples: Spreaders, emulsifiers, wetting agents, detergents.

SUSCEPTIBLE SPECIES: A plant, animal or microorganism that is affected by pesticides at the rates listed on the label.

SUSPENSION: A pesticide mixture consisting of finely ground solid particles dispersed or floating in a liquid, usually water or oil. Agitation is usually required to keep the particle from settling out of suspension. Example: Wettable powders in water.

SYNERGISM: When the effect of two or more pesticides applied together is greater than the sum of the individual pesticides applied separately. Example: Pesticide X kills 40 percent of an insect population, Pesticide Y kills 20 percent. When applied together, X and Y kill 95 percent.

SYSTEMIC: A process by which a chemical is taken up and translocated within a plant or animal.

TANK MIX: The mixture of two or more compatible pesticides in a spray tank in order to apply them simultaneously.

TARGET: The plants, animals, structures, areas, or pests to be treated with a pesticide application.

TECHNICAL MATERIAL: The pesticide chemical in pure form as it is manufactured by a chemical company prior to being formulated into wettable powders, dusts, emulsifiable concentrates, granules, etc.

TEMPORARY TOLERANCE: A tolerance established on an agricultural commodity by EPA to permit a pesticide manufacturer or his agent time, usually one year, to collect additional residue data to support a petition for a permanent tolerance; in essence, an experimental tolerance. (See tolerance).

TERATOGENIC: The property of a substance or agent to produce abnormalities or defects in living human or animal embryos and fetuses. These defects are ordinarily not inheritable.

TOLERANCE: By law, a regulation that establishes the maximum amount of a pesticide chemical (active ingredient) that may remain in or on a raw agricultural commodity (food or feed product) at harvest or slaughter.

TOLERANT: The property of some plants, animals, and microorganisms including pests to withstand a certain degree of injury by pesticides. Also, the property of living organisms to withstand stress or adversity such as disease, insect attack, dry weather, severe cold, etc. (See resistant).

TOXIC: Poisonous to living organisms.

TOXICANT: A poisonous substance such as the active ingredient in pesticide formulations that can injure or kill plants, animals, or microorganisms.

TOXICITY: The degree or extent that a chemical or substance is poisonous. Toxicity is measured by oral, dermal, and inhalation tests on animals.

TOXIN: A naturally occurring poison produced by plants, animals, or microorganisms. Examples: The poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

TRADE NAME: Same as brand name.

TRANSLOCATED PESTICIDE: A pesticide chemical that has moved within a plant or animal from the site of entry. A systemic pesticide is translocated.

ULV: Ultra Low Volume. No water is applied with this pesticide formulation. Spray concentrates are frequently used in ULV applications.

VAPOR PRESSURE: The property which causes a liquid to evaporate. The higher the vapor pressure, the more volatile the chemical.

VECTOR: An animal (insect, nematode, mite, etc.) or plant (dodder) that can carry and transmit a pathogen from one host to another.

VERTEBRATE ANIMALS: A major category of animals characterized by a segmented backbone.

VIRUS: An ultramicroscopic structure composed of high molecular weight proteins and capable of passing through bacterial filters. Viruses can only multiply in living tissues. They cause many animal and plant diseases.

VOLATILE: The property of a substance readily changing from the liquid or solid state to a gas at ordinary temperatures upon exposure to air.

WARNING: See signal word.

WEED: A plant growing in a place where it is not wanted.

WETTABLE POWDER: A solid (powder) pesticide formulation which forms a suspension when added to water.

WETTING AGENT: A compound which reduces surface tension and improves contact between surfaces.

WINTER ANNUAL: Plants which germinate in the fall and complete their life cycle by early summer.